Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

USDA

United States
Department of
Agriculture

Animal and
Plant Health
Inspection
Service

Veterinary
Services

National
Animal Health
Monitoring
System

January 2010

Dairy 2007

Heifer Calf Health and Management Practices on U.S. Dairy Operations, 2007

USDA:APHIS:VS:CEAH
NRRC Building B, M.S. 2E7
2150 Centre Avenue
Fort Collins, CO 80526-8117
970.494.7000
E-mail: NAHMS@aphis.usda.gov
http://nahms.aphis.usda.gov

N550.0110

Selected Highlights of Heifer Calf Health and Management Practices

The Dairy 2007 study marks the first time in 15 years that the National Animal Health Monitoring System has taken an in-depth look at dairy heifer calf health and management. Here are a few highlights from this report:

During 2006, almost 9 of 10 cows and heifers (86.0 percent) delivered a calf that was alive at 48 hours. Overall, 8.1 percent of calves were stillborn during 2006.

Approximately 6 of 10 operations (60.5 percent) had guidelines on when to intervene during calving for both heifers and cows, and more than 9 of 10 operations (91.9 percent) provided training in calving intervention for owners/employees of the operation.

The majority of operations (59.2 percent) hand-fed colostrum to calves from a bucket or bottle. On average, calves received hand-fed colostrum 3.3 hours following birth. About one-third of operations (36.3 percent) allowed calves to ingest colostrum during first nursing of the dam.

Almost one of five heifer calves (19.2 percent) had failure of passive transfer of immunity based on serum IgG testing. Calves allowed to nurse the dam were more likely to have failure of passive transfer than calves that did not nurse. Assessment of passive transfer level using serum total protein agreed with IgG classification of passive transfer level in 75.4 percent of calves.

The operation average age of heifers at weaning was 8.2 weeks, with large operations weaning calves at an older age (9.1 weeks) than medium and small operations (7.9 and 8.2 weeks, respectively). The median weight at 2 months of age (56 to 62 days) for Holstein heifer calves was 177 pounds.

About 1 of 10 operations (9.3 percent) raised any dairy heifers off the operation. More than two of three operations (69.5 percent)—housing 78.7 percent of heifer calves—did not allow preweaned calves to have contact with older cattle.

During 2006, 7.8 percent of preweaned heifers and 1.8 percent of weaned heifers died. Scours, diarrhea, or other digestive problems accounted for the majority of preweaned heifer deaths (56.5 percent). Respiratory disease was the single largest cause of weaned heifer deaths (46.5 percent).

ACKNOWLEDGEMENTS

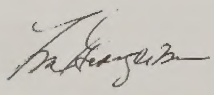
This study was a cooperative effort between two U.S. Department of Agriculture (USDA) Agencies: the National Agricultural Statistics Service (NASS) and the Animal and Plant Health Inspection Service (APHIS).

Recognition goes to the NASS enumerators, State and Federal veterinary medical officers (VMOs), and animal health technicians (AHTs) who visited the operations and collected the data for the Dairy 2007 study. Their hard work and dedication to USDA's National Animal Health Monitoring System (NAHMS) were invaluable. The roles of the producers, area veterinarians in charge (AVICs), NAHMS coordinators, VMOs, AHTs, and NASS enumerators were critical in providing quality data for Dairy 2007 reports. Thanks also goes to the personnel at the Centers for Epidemiology and Animal Health for their efforts in generating and distributing valuable reports from Dairy 2007 data.

Additional biological sampling and testing were afforded by the generous contributions of collaborators for the Dairy 2007 study, including

- USDA:APHIS, National Veterinary Services Laboratories;
- USDA:ARS, Beltsville Agricultural Research Center;
- USDA:ARS, Russell Research Center;
- Antel BioSystems, Inc.;
- Cornell University Animal Health Diagnostic Laboratory;
- Quality Milk Production Services;
- Tetracore, Inc.;
- University of Pennsylvania, New Bolton Center;
- University of Wisconsin, Madison; and
- Wisconsin Veterinary Diagnostic Laboratory.

All participants are to be commended, particularly the producers whose voluntary efforts made the Dairy 2007 study possible.



Larry M. Granger
Director
Centers for Epidemiology and Animal Health

Suggested bibliographic citation for this report:
USDA. 2010. Dairy 2007, Heifer Calf Health and Management Practices on U.S. Dairy Operations, 2007
USDA:APHIS:VS, CEAH. Fort Collins, CO
#550.0110

Contacts for further information:
Questions or comments on data analysis: Dr. Jason Lombard
(970) 494-7000
Information on reprints or other reports: Ms. Kathy Snover
(970) 494-7000
E-mail: NAHMS@aphis.usda.gov

Feedback
Feedback, comments, and suggestions regarding the Dairy 2007 study reports are welcomed. Please forward correspondence via e-mail at: NAHMS@aphis.usda.gov, or you may submit feedback via online survey at: http://nahms.aphis.usda.gov
(Click on "FEEDBACK on NAHMS reports.")

Table of Contents

Introduction 1

Calf Management 1

Study Development 1

Terms Used In This Report 4

Section I: Population Estimates 7

A. Calving 7

1. Introduction 7
2. Maternity housing 7
3. Calving area 8
4. Calving personnel 16
5. Births 19
6. Stillbirths 20

B. Dystocia Management 22

1. Introduction 22
2. Guidelines for calving intervention 24
3. Training personnel 26
4. Calving difficulty scoring 26
5. Observation close to calving 28
6. Intervention 34
7. Veterinary assistance 42
8. Assistance for compromised calves 46

C. Colostrum Management and Passive Transfer Status 50

1. Colostrum management 50
2. Pasteurizing colostrum 58
3. Measuring passive transfer of immunity 59
4. Calf IgG passive transfer status 61
5. Calf serum total protein passive transfer status 69
6. Comparison of IgG and total protein status 73

D. Nutrition 74

1. Introduction 74
2. Liquid diets (milk/milk replacer) 74
3. Water and calf starter 80

E. Growth from Birth to Weaning 82
1. Introduction 82
2. Holstein growth parameters 83

F. General Management 87
1. Housing 87
2. Off-site heifer raising 89
3. Weaning age 96
4. Preventive practices 97
5. Injection practices 100
6. Vaccination practices 101
7. Bovine viral diarrhea 103

G. Surgical Procedures 106
1. Dehorning 106
2. Extra teat removal 113
3. Tail docking 114

H. Biosecurity 118
1. Introduction 118
2. Source of heifer inventory 119
3. Animals brought onto the operation 119
4. Quarantine of herd additions 121
5. Calf contact with other cattle 121

I. Health 122
1. Morbidity and antibiotic use in preweaned heifers 122
2. Morbidity and antibiotic use in weaned heifers 125

J. Mortality and Carcass Disposal 129
1. Mortality 129
2. Necropsy 129
3. Cause of death 130
4. Carcass disposal 132

Section II: Methodology 133
A. Needs Assessment 133

B. Sampling and Estimation 134
1. State selection 134
2. Operation selection 135
3. Animal selection for IgG sampling 135
4. Population inferences 136

C. Data Collection 136

D. Data Analysis 137
Validation 137

E. Sample Evaluation 137
1. Phase I: General Dairy Management Report 137
2. Phase II: VS Initial Visit 139
3. Phase II: VS Second Visit 140

Appendix I: Sample Profile 141
Responding Operations 141

Appendix II: Sample Profile for Passive Transfer Status and Growth 142
1. Number of calves sampled for IgG testing by age 142
2. Number of calves sampled for IgG testing by season 142
3. Number of preweaned heifer calves measured for growth, by age and breed 143

Appendix III: Antibiotic/Antimicrobial Class 144

Appendix IV: U.S. Milk Cow Population and Operations 147

Appendix V: Study Objectives and Related Outputs 148

Appendix VI: References 150

Introduction

Calf Management

Calf management is an important aspect of dairy operations. Calf health is important to the long-term success of operations because heifer calves typically have better genetics (e.g., they are more productive) than adult cows and represent the future dairy herd. Producers should consider resources allocated to calf management as investments in the future.

Maximizing calf health is not easy. Young calves face numerous challenges: the birthing process, acquiring an adequate amount of high-quality colostrum, avoiding infectious diseases, and the impact of other stressors such as weaning and dehorning. Because of these challenges, preweaned calves have the highest morbidity and mortality rates of any age dairy cattle. Studies have estimated the proportion of stillbirths in dairy calves to be between 7 and 8 percent (7.1 percent–Meyer et al., 2000; 8.1 percent – USDA, 2007). Of calves born alive, an additional 7.8 percent die prior to weaning (USDA, 2007), bringing the overall preweaning calf mortality on dairy operations to approximately 15 percent. It is important to realize that the costs of poor calf management go beyond just calf mortality losses. For example, failure of passive transfer of immunity in calves not only results in increased mortality early in life (Wells et al., 1996), but also has long-term effects on calves' lives. Failure of passive transfer in heifer calves is linked with decreased rate and efficiency of growth and decreased first and second lactation milk production (Faber, 2005). Management practices including calving management, colostrum administration, nutrition, biosecurity, and vaccination can impact the overall health and productivity of the dairy herd.

For these reasons, excellent calf health and management should be a high priority. The purpose of this report is to examine dairy calf health and calf management practices in the United States.

Study Development

The National Animal Health Monitoring System (NAHMS) is a nonregulatory division of the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service. NAHMS is designed to help meet the Nation's animal-health information needs and has collected data on dairy health and management practices through three previous studies.

The NAHMS 1991-92 National Dairy Heifer Evaluation Project (NDHEP) provided the dairy industry's first national information on the health and management of dairy cattle in the United States. Just months after the study's first results were released in 1993, cases of acute bovine viral diarrhea (BVD) surfaced in the United States following a 1993 outbreak in Canada. NDHEP information on producer vaccination and biosecurity practices helped officials address the risk of disease spread and target educational efforts on vaccination protocols. An outbreak of human illness was reported in 1993 in the Pacific Northwest, this time related to *Escherichia coli* 0157:H7. NDHEP data on the bacteria's prevalence in dairy cattle helped officials define public risks as well as research needs. This baseline picture of the industry also helped identify additional research

and educational efforts in various production areas, such as feed management and weaning age.

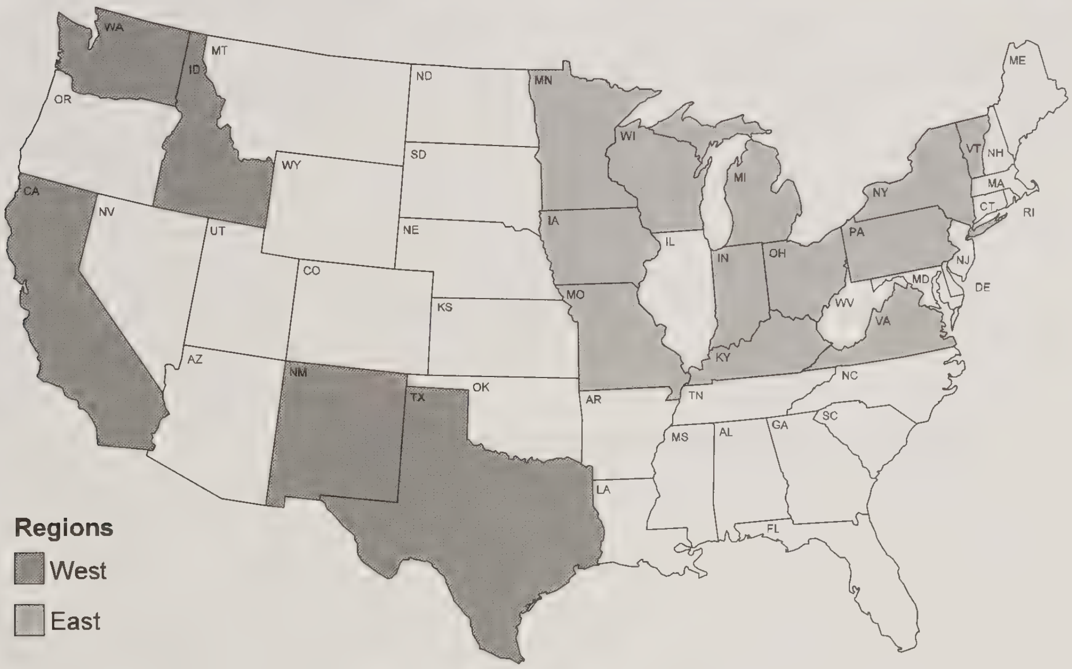
Information from the NAHMS Dairy '96 study helped the U.S. dairy industry identify educational needs and prioritize research efforts on such timely topics as antibiotic usage and Johne's disease, as well as digital dermatitis, bovine leukosis virus, and potential foodborne pathogens, including *E. coli*, *Salmonella*, and *Campylobacter*.

A major focus of the Dairy 2002 study was to describe management strategies that prevent and reduce Johne's disease and to determine management factors associated with *Mycoplasma* and *Listeria* in bulk-tank milk. Additionally, levels of participation in quality assurance programs, the incidence of digital dermatitis, a profile of animal waste handling systems used on U.S. dairy operations, and industry changes since the NDHEP in 1991 and Dairy '96 were examined.

The Dairy 2007 study was conducted in 17 of the Nation's major dairy States (see map on following page) and provides participants, stakeholders, and the industry as a whole with valuable information representing 79.5 percent of U.S. dairy operations and 82.5 percent of the U.S. dairy cows. Phase I data were collected from 2,194 dairy operations by National Agricultural Statistics Service enumerators January 1-31, 2007. For phase II of the Dairy 2007 study, data were collected from a subset of Phase 1 participants (582 operations with 30 or more dairy cows). Phase II data were collected by State and Federal veterinary medical officers (VMOs) and animal health technicians (AHTs) between February 26 and August 31, 2007.

One objective of the Dairy 2007 study was to describe dairy calf health and nutrition from birth to weaning and evaluate heifer disease prevention practices. This report provides all calf-related information collected during the Dairy 2007 study.

Dairy 2007 Participating States



Information on the methods used and number of respondents in the study can be found at the end of this report.

All Dairy 2007 study reports, as well as reports from previous NAHMS dairy studies, are available online at http://nahms.aphis.usda.gov.

For questions about this report or additional copies, please contact:

USDA-APHIS-VS-CEAH
NRRC Building B, M.S. 2E7
2150 Centre Avenue
Fort Collins, CO 80526-8117
970.494.7000

Terms Used In This Report

Amniotic sac: The fluid-filled sac surrounding the calf in the uterus, also referred to as the water bag.

Antibiotics: Substances produced by microorganisms that kill or inhibit the growth of other microorganisms. For the purpose of this report, antibiotics are synonymous with antimicrobials.

Antimicrobial: Any substance that kills or inhibits the growth of microorganisms.

Bovine viral diarrhea: an infectious disease of cattle caused by a pestivirus. Infection can result in embryonic death, abortion, stillbirths, and congenital defects such as cerebellar agenesis that results in ataxia or lack of coordination.

Colostrum: The mammary secretion harvested immediately after calving, which is rich in immunoglobulins (maternal antibodies) and other nutrients.

Cow: Female dairy bovine that has calved at least once.

Dam: The maternal parent.

Dry period: The period from the end of one lactation to the beginning of a new lactation.

Dystocia: Delayed, abnormal, or difficult calving which usually requires intervention to deliver the calf.

ELISA: Enzyme-linked immunosorbent assay.

Estrous: Pertaining to estrus or in reference to the entire reproductive cycle (i.e., estrous cycle).

Estrus: The period during the reproductive cycle when the female displays interest in mating and will stand to be mounted. Behavioral signs of estrus, in addition to standing to be mounted, include passage of clear mucus from the vulva and swelling of the vulva.

Forestomach: A collective term for the rumen, reticulum, and omasum of the ruminant stomach.

Heifer: Female dairy bovine that has not yet calved.

Helminth: A parasitic worm.

Herd size: Herd size is based on January 1, 2007, dairy cow inventory. Small herds are those with fewer than 100 head, medium herds are those with 100 to 499 head, and large herds are those with 500 or more head.

Hypocalcemia: Low calcium level in blood.

IgG: Immunoglobulin G, one of several proteins that function as antibodies, a component of the immune system which helps an animal to fight disease.

Immunoglobulins: Proteins that function as antibodies, a component of the immune system that helps an animal fight disease.

Ionophore: Feed additive that enhances feed efficiency in cattle by altering ruminal fermentation by facilitating the transport of ions across cell membranes. Ionphores are also used to control coccidiosis infections in calves. The Food and Drug Administration (FDA), which approves and regulates animal drugs, considers ionophores a type of antibiotic.

Milk fever: Common name for hypocalcemia or low blood calcium levels, common in cows around the time of calving.

Multiparous: Female dairy bovine that has given birth two or more times.

Nonsaleable milk: Milk that is not sold for human consumption, typically includes waste milk, transition milk, and colostrum.

Operation: The definition of operation for Phase I of the Dairy 2007 study was: premises with at least one dairy cow on January 1, 2007. For Phase II it was: premises with at least 30 dairy cows on January 1, 2007. This report contains data from both phases.

Operation average: The average value for all operations. A single value for each operation is summed over all operations reporting divided by the number of operations reporting. For example, the operation average number of calving personnel (see table a, p 16) was calculated by summing the number of hours following birth that calves usually got their first colostrum feeding over all operations divided by the number of operations.

Parturition: The process of giving birth.

Passive transfer: The process by which the cow passes immunoglobulins via colostrum (for protection against disease) to the calf.

PCR: Polymerase chain reaction.

Placenta: A structure in the uterus that allows transport of nutrients and waste products between the dam and the fetus during pregnancy. The placenta is expelled following birth.

Population estimates: The estimates in this report make inference to all operations or dairy cattle in the target population (see Methodology, p 133). Data from the operations responding to the survey are weighted to reflect their probability of selection during sampling and to account for any survey nonresponse.

Precision of population estimates: Estimates in this report are provided with a measure of precision called the standard error. A 95-percent confidence interval can be created with bounds equal to the estimate plus or minus two standard errors. If the only error is sampling error, the confidence intervals created in this manner will contain the true population mean 95 out of 100 times. In the example to the right, an estimate of 7.5 with a standard error of 1.0 results in limits of 5.5 to 9.5 (two times the standard error above and below the estimate). The second estimate of 3.4 shows a standard error of 0.3 and results in limits of 2.8 and 4.0. Alternatively, the 90-percent confidence interval would be created by multiplying the standard error by 1.65 instead of 2.

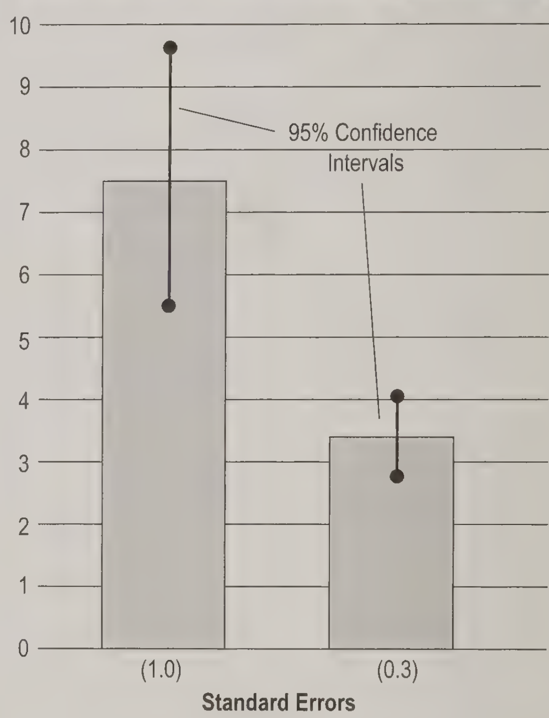
Most estimates in this report are rounded to the nearest tenth. If rounded to 0, the standard error was reported (0.0). If there were no reports of the event, no standard error was reported (--). References to estimates being higher or lower than other estimates are based on the 95 percent- confidence intervals not overlapping.

Primiparous: Female dairy bovine that has only given birth once or is pregnant for the first time.

Regions:

- **West:** California, Idaho, New Mexico, Texas, and Washington
- **East:** Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Vermont, Virginia, and Wisconsin

Examples of a 95% Confidence Interval



Sample profile: Information that describes characteristics of the operations from which Dairy 2007 data were collected.

Transition milk: The mammary secretion harvested in the period between colostrum and normal milk, often considered waste or nonsaleable milk.

Usual calving area: An area separate from housing for lactating cows designated specifically for calving. Tie stalls or stanchions were not considered usual calving areas for the purpose of this report.

Section I: Population Estimates

Note: Unless otherwise specified, estimates in the following tables represent only operations with 30 or more dairy cows.

A. Calving

1. Introduction

The goal of the calving event is to have a live, healthy calf and cow. Preparation for successful calving begins long before the date of parturition. About 60 days before calving, the dry period begins for lactating dairy cows. The length of the dry period and the nutrition provided during this time are important to the health of the cow and the calf. Dry periods shorter than 40 days can result in decreased quantities of colostrum as well as decreased milk production in the subsequent lactation. Dry periods shorter than 21 days may result in decreased quality of colostrum.

2. Maternity housing

During the dry period, nonlactating (dry) cows should be segregated from the lactating herd to allow the producer to formulate different diets to meet the specific needs of each group. Limiting potassium intake and providing anionic salts to dry cows help to prevent milk fever and can be implemented when dry cows are housed separately from lactating cows.

Dry cow or maternity housing was separate from lactating cow housing on 60.0 percent of operations, and the percentage of operations that used separate housing increased as herd size increased.

Percentage of operations in which maternity housing was separate from housing used for lactating cows, by herd size

Percent Operations*							
Herd Size (Number of Cows)							
Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
51.5	(1.7)	80.8	(1.8)	90.4	(2.0)	60.0	(1.3)

*Operations with any dairy cows.

3. Calving area

Cows are generally moved from the far-off dry cow area to a close-up dry cow area when they are about 3 weeks from calving. Expected calving dates are determined based on service date and gestation length. The average gestation period for a cow is approximately 282 days; the gestation period for Ayrshires, Holsteins, and Jerseys is usually closer to 279 days, while Brown Swiss and Guernsey gestations are about 288 and 283 days, respectively (Brakel et al., 1952; Merck, 1998).

Ideally, cows should be moved from the close-up dry cow area into the calving pen as close to calving as possible. If the cows spend too long in the calving pen, the cleanliness of the area can be compromised. The calving area should be clean, dry, quiet, and provide 100-125 square feet of resting space per cow, enough to allow the cow to lie down comfortably and deliver a calf. It should have good lighting to facilitate observation and should be isolated from other areas of the dairy to prevent the cow from becoming distracted or stressed by commotion from other farm tasks. Individual calving pens that can be cleaned between uses are ideal for the prevention of disease. However, group calving pens, if managed well, can also be effective. Group pens require fewer workers for monitoring, which can be desirable on larger dairies. In addition, sick cattle or animals that have tested positive for Johne's disease should not be allowed in the calving area, since they can transmit diseases to calves (Davis and Drackley, 1998; Mee, 2008).

The majority of operations (70.0 percent) used a multiple-animal calving area/pen. A lower percentage of small operations (65.6 percent) used a multiple-animal calving area compared with medium operations (79.8 percent). Approximately one-fourth of operations used an individual calving area that was either cleaned between each calving or cleaned after two or more calvings (25.5 and 26.2 percent, respectively). A higher percentage of small operations (30.6 percent) used an individual-animal pen that was cleaned between each calving compared with medium and large operations (14.6 and 13.5 percent, respectively). Some operations listed more than one type of calving area.

a. Percentage of operations by areas used for calving, and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Calving Area	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Multiple-animal area/pen	65.6	(3.5)	79.8	(3.5)	78.5	(4.3)	70.0	(2.6)
Individual-animal area/pen cleaned between each calving	30.6	(3.4)	14.6	(3.3)	13.5	(3.9)	25.5	(2.5)
Individual-animal area/pen cleaned after two or more calvings	25.4	(3.3)	27.4	(3.7)	30.3	(5.6)	26.2	(2.5)
Other	5.1	(1.7)	3.6	(1.4)	3.1	(1.7)	4.6	(1.2)

The usual calving area was defined as an area separate from housing for lactating cows designated specifically for calving. Tie stalls or stanchions were not considered usual calving areas for the purpose of this report. The percentage of operations with a usual calving area ranged from 62.5 percent of small operations to 98.2 percent of large operations.

b. Percentage of operations that had a usual calving area, by herd size

Percent Operations							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Percent	Std. Error	Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
62.5	(3.8)	83.7	(3.3)	98.2	(1.2)	70.1	(2.7)

A higher percentage of operations in the West region than in the East region had a usual calving area (88.7 and 68.3 percent, respectively). This difference is likely due to the different types of housing used for lactating cows in the two regions. Operations in the West region are generally larger and most often house cows in loose housing systems such as freestalls or drylots, which necessitate the use of dedicated calving areas. Cows in the East region are often housed in smaller tie stall/ stanchion barns and calve in their respective stalls. These types of facilities were not considered usual calving areas in this report.

c. Percentage of operations that had a usual calving area, by region

Percent Operations			
Region			
West		East	
Percent	Standard Error	Percent	Standard Error
88.7	(3.8)	68.3	(3.0)

Of operations with a usual calving area, 4 of 10 (39.9 percent) moved cows into the calving area within a day prior to calving; there were no differences by region. Cows were kept in the calving area prior to calving for 3.1 to 14.0 days on 26.6 percent of operations and for 14.1 or more days on 18.9 percent of operations.

d. For the 70.1 percent of operations with a usual calving area, percentage of operations by number of days cows remained in the usual calving area/pen *prior* to calving, and by region

	Percent Operations					
	Region					
	West		East		All Operations	
Number of Days	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
1 or less	28.6	(4.9)	41.4	(3.6)	39.9	(3.2)
1.1 to 3.0	8.3	(2.9)	15.4	(2.6)	14.6	(2.3)
3.1 to 14.0	36.4	(5.6)	25.3	(3.1)	26.6	(2.8)
14.1 or more	26.7	(4.9)	17.9	(2.5)	18.9	(2.3)
Total	100.0		100.0		100.0	

Of operations with a usual calving area, only 12.9 percent removed cows from the calving area in the first hour after calving. A lower percentage of large operations (6.2 percent) allowed cows to remain in the usual calving area for 14.1 or more hours compared with small operations (25.0 percent).

e. For the 70.1 percent of operations with a usual calving area, percentage of operations by number of hours cows remained in the usual calving area/pen *after* calving, and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Number of Hours	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Removed immediately	4.4	(1.8)	2.7	(1.3)	7.2	(3.0)	4.2	(1.2)
0.25 to 1.0	8.0	(2.3)	7.8	(2.1)	16.5	(3.8)	8.7	(1.6)
1.1 to 3.0	22.5	(4.0)	26.1	(4.0)	28.0	(5.4)	24.1	(2.8)
3.1 to 14.0	40.1	(4.6)	44.0	(4.4)	42.1	(5.5)	41.4	(3.2)
14.1 or more	25.0	(4.2)	19.4	(3.9)	6.2	(3.2)	21.6	(2.8)
Total	100.0		100.0		100.0		100.0	

There were no regional differences by length of time that cows remained in the usual calving area after calving.

f. For the 70.1 percent of operations with a usual calving area, percentage of operations by number of hours cows remained in the usual calving area/pen *after* calving, by region

	Percent Operations			
	Region			
	West		East	
Number of Hours	Percent	Std. Error	Percent	Std. Error
Removed immediately	6.7	(2.7)	3.9	(1.3)
0.25 to 1.0	7.3	(2.7)	8.9	(1.7)
1.1 to 3.0	22.6	(4.9)	24.3	(3.1)
3.1 to 14.0	44.6	(5.8)	41.0	(3.5)
14.1 or more	18.8	(4.9)	21.9	(3.2)
Total	100.0		100.0	

A higher percentage of small and medium operations (37.3 and 33.0 percent, respectively) allowed sick cows into calving areas than large operations (16.5 percent). Approximately one-half of operations (51.6 percent) allowed lame cows into the calving area. A lower percentage of large operations (28.6 percent) allowed lame cows into the calving area than medium and small operations (57.9 and 51.8 percent, respectively).

g. For the 70.1 percent of operations with a usual calving area, percentage of operations that allowed sick/lame cows in the usual calving area, by cattle class and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Cattle Class	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Sick cows	37.3	(4.6)	33.0	(4.5)	16.5	(4.4)	34.2	(3.2)
Lame cows	51.8	(4.6)	57.9	(4.4)	28.6	(4.5)	51.6	(3.1)
Other	5.4	(2.0)	5.8	(2.3)	4.1	(2.2)	5.4	(1.4)
Any of the above	56.4	(4.6)	62.3	(4.2)	30.7	(4.6)	55.8	(3.1)

Cows that test positive for Johne's disease present a risk of contaminating the usual calving area and transmitting disease to newborn calves. To prevent calving-area contamination and the potential for infecting calves, test-positive cows should not be allowed in the calving area or other calf areas. Of all operations, 28.3 percent had a usual calving area and tested for Johne's disease. A higher percentage of medium operations had a usual calving area and tested for Johne's disease compared with small operations.

h. Percentage of operations that had a usual calving area and tested for Johne's disease, by herd size

Percent Operations							
Herd Size (Number of Cows)							
Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
23.4	(3.2)	39.6	(4.0)	37.1	(5.6)	28.3	(2.4)

There were no differences by herd size in the percentage of operations that allowed Johne's disease test-positive animals into the calving area; 15.5 percent of operations that had a usual calving area and tested for Johne's disease allowed test-positive cows into the calving area.

i. For the 28.3 percent of operations with a usual calving area and that tested for Johne's disease, percentage of operations that allowed Johne's test-positive cows in the usual calving area, by herd size

Percent Operations

Herd Size (Number of Cows)

Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
12.0	(4.5)	18.0	(5.0)	30.2	(8.3)	15.5	(3.2)

The percentage of calves born in the usual calving area increased as herd size increased. Overall, 89.8 percent of calves were born in the usual calving area.

j. For the 70.1 percent of operations with a usual calving area, percentage of calves born in the usual calving area, by herd size

Percent Calves

Herd Size (Number of Cows)

Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
79.9	(2.0)	89.0	(1.3)	93.6	(1.3)	89.8	(0.9)

Photo courtesy of Judy Rodriguez

A higher percentage of small operations than large operations reported that less than three-fourths of their calves were born in the usual calving area. A higher percentage of large operations (45.8 percent) reported that 91 to 99 percent of calves were born in the calving area compared with 16.6 percent of small operations.

k. For the 70.1 percent of operations with a usual calving area, percentage of calves born in the usual calving area/pen, by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Percent Calves	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
0 to 50	19.3	(3.8)	8.4	(2.5)	3.7	(2.0)	14.7	(2.5)
51 to 75	18.3	(3.9)	6.5	(2.3)	3.6	(2.0)	13.5	(2.5)
76 to 90	28.6	(4.3)	29.0	(4.2)	24.0	(4.5)	28.3	(3.0)
91 to 99	16.6	(3.2)	38.4	(4.5)	45.8	(5.7)	25.6	(2.5)
100	17.2	(3.3)	17.7	(3.3)	22.9	(5.5)	17.9	(2.3)
Total	100.0		100.0		100.0		100.0	

4. Calving personnel

The operation average number of calving personnel (people with any work duties in the calving area, including employees and family members) was 2.4. As expected, the average number of calving personnel increased as herd size increased.

a. Operation average number of calving personnel by herd size

Operation Average Number of Calving Personnel							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error
2.0	(0.1)	3.0	(0.1)	4.1	(0.3)	2.4	(0.1)

Overall, there was an average of 70.2 cows on the operation for every person with duties in the calving area. On small operations, the ratio of number of cows in the herd to the number of calving personnel was 29.4. On large operations, there was an average of 297.8 cows for each person with calving area duties.

b. Operation average number of cows for each person with duties in the calving area, by herd size

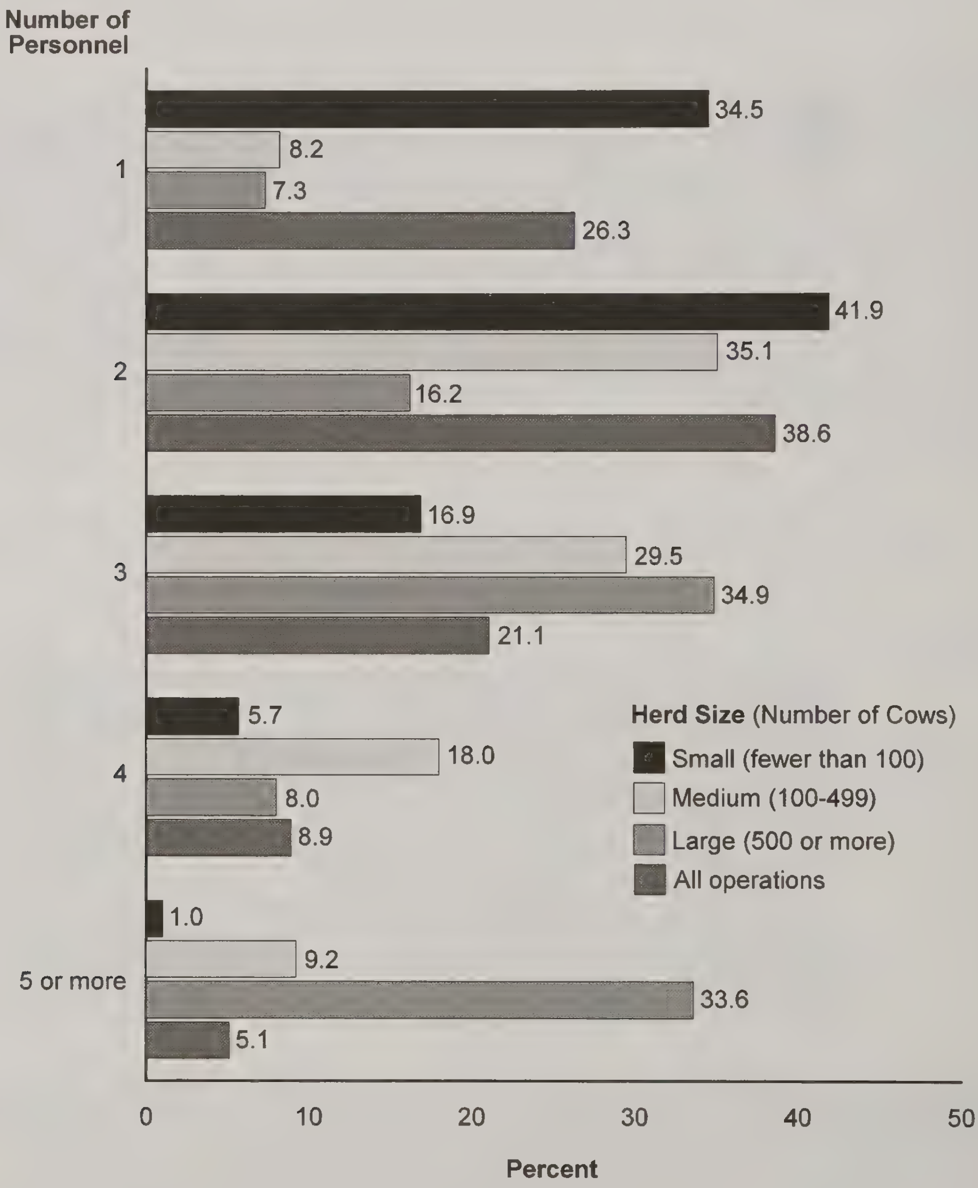
Operation Average Number of Cows per Person							
Herd Size (Number of Cows)							
Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Avg.	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**	**Avg.**	**Std. Error**
29.4	(1.2)	64.0	(3.0)	297.8	(27.7)	70.2	(4.1)

The majority of small operations (76.4 percent) had one or two calving personnel compared with two or three for medium operations (64.6 percent) and three or more for large operations (76.5 percent).

c. Percentage of operations by number of calving personnel, and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Number of Personnel	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
1	34.5	(3.9)	8.2	(2.3)	7.3	(3.7)	26.3	(2.8)
2	41.9	(4.0)	35.1	(4.3)	16.2	(4.7)	38.6	(3.0)
3	16.9	(3.1)	29.5	(4.2)	34.9	(6.4)	21.1	(2.4)
4	5.7	(1.6)	18.0	(3.5)	8.0	(3.3)	8.9	(1.5)
5 or more	1.0	(0.7)	9.2	(2.4)	33.6	(5.5)	5.1	(0.9)
Total	100.0		100.0		100.0		100.0	

Percentage of Operations by Number of Calving Personnel, and by Herd Size



The West region had a higher percentage of operations with five or more calving personnel (16.6 percent) than the East region (4.0 percent), which is probably a reflection of larger herds in the West region.

d. Percentage of operations by number of calving personnel, and by region

	Percent Operations			
	Region			
	West		East	
Number of Personnel	Percent	Std. Error	Percent	Std. Error
1	15.7	(4.8)	27.3	(3.1)
2	35.1	(5.9)	38.9	(3.2)
3	27.4	(5.1)	20.6	(2.6)
4	5.2	(2.5)	9.2	(1.6)
5 or more	16.6	(3.9)	4.0	(0.9)
Total	100.0		100.0	

5. Births

During 2006, almost 9 of 10 cows and heifers (86.0 percent) delivered a calf that was alive at 48 hours.

a. Calves* born during 2006 and alive at 48 hours, as a percentage of January 1, 2007, cow inventory, by region

Region					
West		East		All Operations	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
81.0	(1.1)	89.7	(0.5)	86.0	(0.6)

*Calves on operations with any cows

One-half of calves born in 2006 and alive at 48 hours (50.8 percent) were heifer calves.

b. Heifer calves* as a percentage of all calves born during 2006 and alive at 48 hours, by region

Percent Calves*					
Region					
West		East		All Operations	
Percent	Standard Error	Percent	Standard Error	Percent	Standard Error
52.0	(0.6)	49.9	(0.3)	50.8	(0.3)

*Calves on operations with any cows

6. Stillbirths

Note: Stillbirths were reported on p 61 of NAHMS' "Part I: Reference of Dairy Cattle Health and Management Practices in the United States, 2007–08" report. Stillbirth estimates in Part I represent operations with any cows and are slightly lower than those reported below (6.5 percent versus 8.1 percent of all calves), which represent operations with 30 or more cows.

All medium and large operations had at least one stillborn calf during the previous 12 months, and almost all small operations (94.7 percent) had at least one stillborn calf. Overall, 8.1 percent of calves were stillborn during the previous 12 months.

a. Percentage of operations with stillborn calves and percentage of calves that were stillborn (including calves that were born dead or died within 48 hours of birth) during the previous 12 months, by herd size

	Percent							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Population	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Operations	94.7	(1.8)	100.0	(0.0)	100.0	(0.0)	96.3	(1.3)
Calves*	8.9	(0.4)	8.6	(0.4)	7.2	(0.5)	8.1	(0.3)

*Number of calves stillborn x 100 / number of calves born during 2006.

All operations in the West region and 96.0 percent in the East region had at least one stillbirth. The West region had a lower percentage of stillborn calves than the East region.

b. Percentage of operations with stillborn calves and percentage of calves that were stillborn (including calves that were born dead or died within 48 hours of birth) during the previous 12 months, by region

	Percent			
	Region			
	West		East	
Population	Percent	Std. Error	Percent	Std. Error
Operations	100.0	(0.0)	96.0	(1.4)
Calves*	6.6	(0.5)	8.9	(0.3)

*Number of calves stillborn x 100 / number of calves born during 2006.

The majority of stillborn calves were born dead (78.6 percent), while the remaining 21.4 percent were born alive but died within 48 hours of birth.

c. For the 8.1 percent of calves that were stillborn during the previous 12 months, percentage of stillborn calves by time of death and by herd size

	Percent Stillborn Calves							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Time of Death	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Born dead	73.8	(2.2)	77.7	(2.0)	83.1	(2.5)	78.6	(1.4)
Born alive, but died within 48 hr	26.2	(2.2)	22.3	(2.0)	16.9	(2.5)	21.4	(1.4)
Total	100.0		100.0		100.0		100.0	

B. Dystocia Management

Note: Unless otherwise specified, estimates in the following tables represent only operations with 30 or more dairy cows.

1. Introduction

Providing the proper assistance at calving, especially during dystocia or calving difficulty, can significantly reduce dairy calf morbidity and mortality. Dairy producers and personnel should be properly trained in correct calving practices, including

- The normal calving process and signs of an abnormal calving,
- How frequently the dam should be observed during calving,
- How to intervene during calving, and
- When to call for professional help.

Current guidelines suggest that the dam should be observed at least every 3 hours during calving (Mortimer, 2009). It is important to understand the stages of labor in order to know when to intervene during calving. Labor is classified into three stages.

Stage 1: Characterized by cervical dilation and uterine contractions, which are usually not evident as abdominal contractions. Cattle during this stage may show signs of restlessness due to the discomfort of the uterine contractions, and they often seek isolation. Stage 1 usually lasts for 2 to 6 hours but may be longer in heifers. Intervention is needed if stage 1 labor lasts longer than 8 hours. Common reasons that cows do not to progress from stage 1 to stage 2 include uterine inertia (hypocalcemia) and some types of abnormal deliveries (Mortimer, 2009).

Stage 2: Uterine contractions continue and abdominal contractions become evident (the dam is noticeably pushing). Stage 2 ends in the delivery of the fetus or fetuses and usually takes less than 2 hours for mature cows but up to 4 hours for heifers. During this stage, the posture, presentation, and position of the fetus are important. Posture refers to the orientation of the fetus' legs and head compared to the dam. Position refers to whether the fetus is right side up (normal) or upside down (abnormal). Presentation refers to which part of the calf is exiting the birth canal first; examples are breech (tail coming first), backward or posterior (back feet coming first) and normal or anterior (front feet coming first). Intervention is recommended if any of the following situations occur during stage 2 of labor:

- Delivery is abnormal (abnormal presentation, posture or position)
- Cow or calf experiences undue stress or weakness (for instance, the calf has a swollen tongue)
- Cow makes no progress despite 30 minutes of active labor
- Cow stops pushing for more than 15 to 20 minutes (breaks are normal but they should not last more than 5 to 10 minutes unless the cow is moved during Stage 2 labor)
- Amniotic sac has been visible for 2 hours or more, and the cow is not pushing (Mortimer, 2009)

Stage 3: Results in the expulsion of the fetal membranes (placenta) due to continued uterine contractions. The placenta is normally expelled within 8 to 12 hours after calving; longer than this constitutes a retained placenta, and treatment may be needed.

Many factors contribute to dystocia. The most common cause of dystocia in primiparous dams is a calf too large relative to the size of the dam's pelvic canal. Dystocia in multiparous dams is usually caused by abnormal presentation, posture, or position of the calf, and maternal causes such as uterine inertia (Arthur et al., 1989). Studies have shown that a higher percentage of heifers than cows experience dystocia. Dystocia rates over a 12-year period were reported based on 666,341 dairy calving records from the Mid States Dairy Record Processing Center. The estimated dystocia rate for heifers (primiparous) was 28.6 percent and for cows (multiparous) 10.7 percent (Meyer et al., 2001). In a study conducted on three Colorado dairies (Lombard et al., 2007), dystocia rates were 51.2 percent for heifers and 29.4 percent for cows.

Dystocia is an important problem for dairy operations because it has a negative impact on calf health. Calves experiencing a dystocia have a higher risk of being stillborn. In dairy cattle, stillborn is usually defined as death at or within 24 to 48 hours of delivery (Philipsson et al., 1979). The reported stillbirth rate for dairy calves based on 666,341 calving records was 7 percent (Meyer et al., 2000). A study of three Colorado dairies reported a stillbirth rate of 8.2 percent (Lombard et al., 2007). Slight dystocia increased the likelihood of stillbirth by a factor of 2.9 for heifers and 4.7 for cows. For severe dystocia, the likelihood of stillbirth increased by a factor of 6.8 for heifers and 11.4 for cows (Meyer et al., 2001). Calves experiencing severe dystocia that survive the immediate perinatal period have a higher risk of death or illness in the first 120 days of life (Lombard et al., 2007).

When managing dystocia it is important to act in a prompt and patient manner. Once it has been determined that intervention is warranted, several basic guidelines should be followed. Producers and personnel should clean the cow's perineal area with soap or antiseptic, use palpation sleeves and lubrication. Knowing when to call for professional help will also improve calving success. A professional is often a veterinarian but can be anyone who knows enough to better manage the dystocia. Producers should call for help when they do not know what the calving problem is or when they know what the problem is but do not make any progress after 30 minutes of trying to resolve it (Mortimer, 2009).

Calves that experience a dystocia but are alive at birth should be given special attention to improve their odds of survival. Calves experiencing a prolonged dystocia are likely to have low levels of oxygen in their blood (hypoxia), and their blood pH is frequently acidic (acidosis) instead of neutral. These impairments lead to a cascade of events, such as decreased ability to nurse, decreased absorption of IgG, and poor temperature regulation. The

administration of oxygen to calves after dystocia may improve survival. In addition, careful attention to adequate colostrum intake and maintenance of body temperature are critical.

Selective breeding programs may be used to reduce the incidence of dystocia on dairy operations. However, dystocia is caused by multiple factors; genetics alone will not eliminate the problem. Despite this, a breeding program is still a valuable tool for reducing the impact of dystocia. To track the success of any dystocia management plan, dairies should keep records of calving-difficulty scores. Recording and monitoring calving-difficulty scores can assist in selecting sires and in the retention of replacements. A common scoring system is a 5-point system where 1=no assistance, 2=slight problem, 3=needed assistance, 4=considerable force, and 5=extreme difficulty/surgical procedure. A simplified system can also be implemented that categorizes calvings as "no assistance," "mild dystocia," or "severe dystocia." Tracking calvings that required assistance and comparing them with those that did not allows a dairy to monitor dystocia rates and the impact on calf performance.

2. Guidelines for calving intervention

Approximately 6 of 10 operations had guidelines on when to intervene during calving for heifers (60.7 percent), cows (60.5 percent), or both (60.5 percent). There were no differences in the percentage of operations with calving guidelines by herd size or by region.

a. Percentage of operations with general guidelines (e.g., standard operating procedures or established protocols) on when to intervene during calving for heifers, cows, or both, by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Heifers	62.3	(3.8)	56.9	(4.6)	57.4	(6.5)	60.7	(2.9)
Cows	62.3	(3.8)	56.3	(4.6)	57.5	(6.5)	60.5	(2.9)
Both	62.3	(3.8)	56.3	(4.6)	57.4	(6.5)	60.5	(2.9)

b. Percentage of operations with general guidelines (e.g., standard operating procedures or established protocols) on when to intervene during calving for heifers, cows, or both, by region

	Percent Operations			
	Region			
	West		East	
Cattle Class	Percent	Std. Error	Percent	Std. Error
Heifers	54.9	(6.2)	61.2	(3.1)
Cows	54.9	(6.2)	61.1	(3.1)
Both	54.9	(6.2)	61.1	(3.1)

For operations with guidelines for both heifers and cows, about one-half (51.7 percent) used different guidelines for heifers and cows.

c. For the 60.5 percent of operations with guidelines for intervening during calving for both heifers and cows, percentage of operations that used different guidelines for heifers and for cows, by herd size

Percent Operations							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
49.2	(5.3)	57.0	(5.9)	59.7	(7.7)	51.7	(3.9)

3. Training personnel

More than 9 of 10 operations (91.9 percent) provided training in calving intervention for owners/employees. Most operations (90.4 percent) used on-the-job training. Approximately one of four operations (27.0 percent) provided training through discussion/lecture. Some operations used more than one method to train owners/employees in calving intervention.

Percentage of operations by calving-intervention training methods used for owners/employees of the operation

Training Method	Percent Operations	Standard Error
Video	2.4	(0.7)
Discussion/ lecture	27.0	(2.7)
On-the-job	90.4	(1.8)
Other	6.1	(1.5)
Any	91.9	(1.7)

4. Calving difficulty scoring

More than one-third of operations (38.5 percent) had a system for scoring calving difficulty. A higher percentage of large operations (57.9 percent) than small operations (35.2 percent) had a scoring system.

a. Percentage of operations that had a system for scoring calving difficulty, by herd size

Percent Operations Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
35.2	(3.8)	42.6	(4.3)	57.9	(6.1)	38.5	(2.9)

There was no regional difference in the percentage of operations that had a system for scoring calving difficulty.

b. Percentage of operations that had a system for scoring calving difficulty, by region

Percent Operations			
Region			
West		East	
Percent	Standard Error	Percent	Standard Error
35.4	(5.1)	38.8	(3.1)

Of operations with a system for scoring calving difficulty, almost all (91.6 percent) recorded the score for assisted births.

c. For the 38.5 percent of operations that had a system for scoring calving difficulty, percentage of operations that recorded the calving difficulty score for assisted births, by herd size

Percent Operations							
Herd Size (Number of Cows)							
Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
88.5	(4.6)	97.8	(1.4)	93.7	(3.9)	91.6	(3.0)

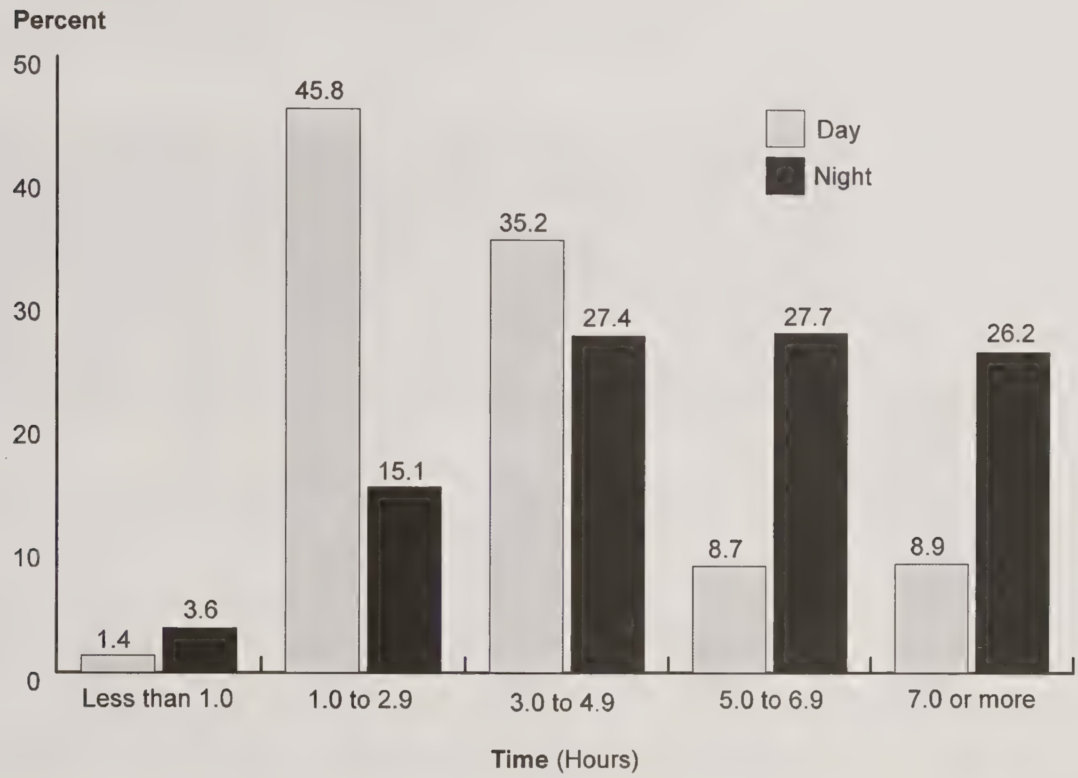
5. Observation close to calving

As expected, females close to calving were observed more frequently during the day than at night. About one-half of operations (47.2 percent) allowed fewer than 3 hours, on average, to pass between observations during the day, with 17.6 percent of operations allowing 5 hours or more between observation periods. During the night, 18.7 percent of operations allowed less than 3 hours to pass between observations, and 53.9 percent let 5 hours or more pass between observation periods.

a. Percentage of operations by average time between observation periods of cattle close to calving, and by time of day

	Percent Operations			
	Day		Night	
Time (Hours)	**Percent**	**Std. Error**	**Percent**	**Std. Error**
Less than 1.0	1.4	(0.6)	3.6	(1.3)
1.0 to 2.9	45.8	(3.0)	15.1	(2.1)
3.0 to 4.9	35.2	(2.9)	27.4	(2.8)
5.0 to 6.9	8.7	(1.8)	27.7	(2.7)
7.0 or more	8.9	(1.8)	26.2	(2.6)
Total	100.0		100.0	

Percentage of Operations by Average Time Between Observation Periods of Cattle Close to Calving, and by Time of Day

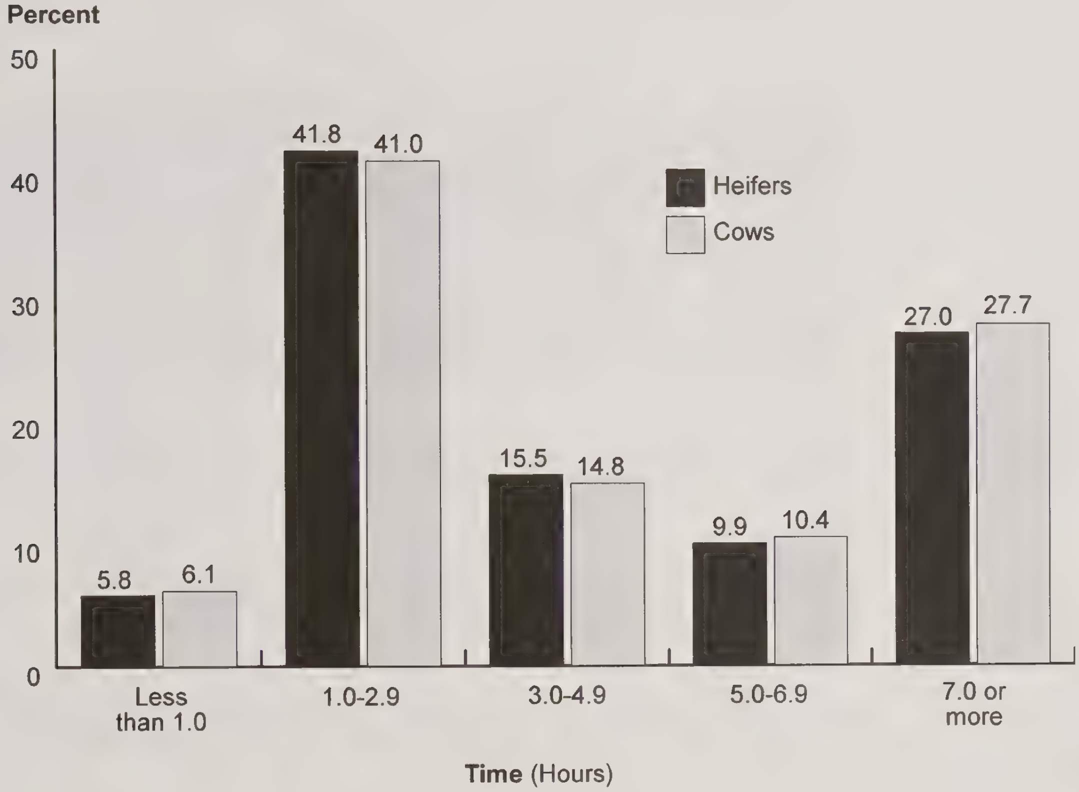


The majority of operations (63.1 percent for heifers and 61.9 percent for cows) would examine or assist an animal before 5 hours elapsed if she showed signs of stage 1 labor without subsequent straining. More than one-fourth of operations (27.0 percent for heifers and 27.7 percent for cows) would wait 7 hours or more to examine or assist an animal that exhibits signs of stage 1 labor without subsequent straining.

b. Percentage of operations by length of time producers would wait to examine or assist an animal when calving is imminent and the heifer or cow is restless/off feed but not observed to be straining

	Percent Operations			
	Heifers		Cows	
Time (Hours)	Percent	Std. Error	Percent	Std. Error
Less than 1.0	5.8	(1.2)	6.1	(1.3)
1.0 to 2.9	41.8	(2.9)	41.0	(2.8)
3.0 to 4.9	15.5	(2.0)	14.8	(1.9)
5.0 to 6.9	9.9	(1.9)	10.4	(2.1)
7.0 or more	27.0	(2.8)	27.7	(2.8)
Total	100.0		100.0	

Percentage of Operations by Length of Time Producers Would Wait to Examine or Assist an Animal When Calving is Imminent and the Heifer or Cow is Restless/Off Feed but not Observed to be Straining

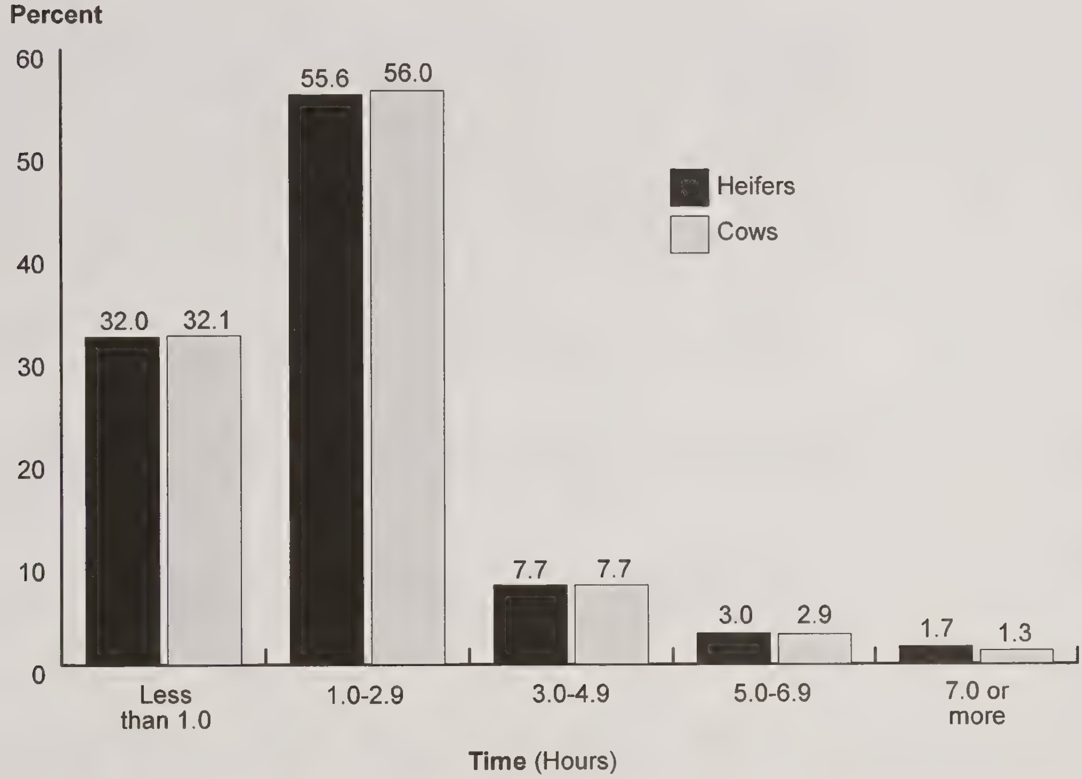


Almost 9 of 10 operations reported that they would wait less than 3 hours to assist heifers or cows that are observed to be straining but are not progressing in delivery (87.6 and 88.1 percent, respectively). Less than 2 percent of operations reported that they would wait 7 hours or more before attending to heifers or cows that are straining but not progressing in delivery.

c. Percentage of operations by length of time producers would wait to examine or assist a heifer or cow that has begun to strain but is not progressing in delivery of the calf

	Percent Operations			
	Heifers		Cows	
Time (Hours)	**Percent**	**Std. Error**	**Percent**	**Std. Error**
Less than 1.0	32.0	(2.9)	32.1	(2.9)
1.0 to 2.9	55.6	(3.0)	56.0	(3.0)
3.0 to 4.9	7.7	(1.5)	7.7	(1.5)
5.0 to 6.9	3.0	(1.2)	2.9	(1.3)
7.0 or more	1.7	(0.9)	1.3	(0.8)
Total	100.0		100.0	

Percentage of Operations by Length of Time Producers Would Wait to Examine or Assist a Heifer or Cow that has Begun to Strain but is not Progressing in Delivery of the Calf



About 95 percent of operations reported that they examine or assist heifers and cows within 3 hours of the water bag appearing at the vulva. Almost one-half of operations would assist heifers and cows within 1 hour of the water bag appearing at the vulva.

d. Percentage of operations by length of time producers would wait before examining or assisting a heifer or cow once the water bag appears at the vulva

	Percent Operations			
	Heifers		Cows	
Time (Hours)	**Percent**	**Std. Error**	**Percent**	**Std. Error**
Less than 1.0	48.4	(2.8)	49.2	(2.8)
1.0 to 2.9	46.2	(2.8)	46.4	(2.8)
3.0 to 4.9	4.1	(1.1)	3.5	(1.0)
5.0 to 6.9	0.6	(0.5)	0.0	(--)
7.0 or more	0.7	(0.5)	0.9	(0.5)
Total	100.0		100.0	

6. Intervention

The practices listed in the following table are generally recommended when a dystocia or difficult calving necessitates intervention. More than 50 percent of operations generally implemented recommended practices, with the exceptions of calling a veterinarian to assist (12.9 percent of operations) and tying or holding the tail out of the way (32.4 percent of operations). A higher percentage of small operations (14.6 percent) than large operations (3.6 percent) would generally call a veterinarian to assist. A higher percentage of large operations than small operations would restrain the cow in a head catch or similar equipment, which might reflect the loose housing systems (such as freestall or drylot) that are more common on large operations than on small operations. Other differences between large and small operations when assisting with delivery included: typically washing the perineum area with soap and water (74.8 and 48.8 percent, respectively), the use of obstetrical gloves (87.1 and 62.5 percent, respectively), and the use of a lubricant (82.2 and 50.4 percent, respectively).

a. Percentage of operations by practice generally implemented once a decision is made to intervene in calving, and by herd size

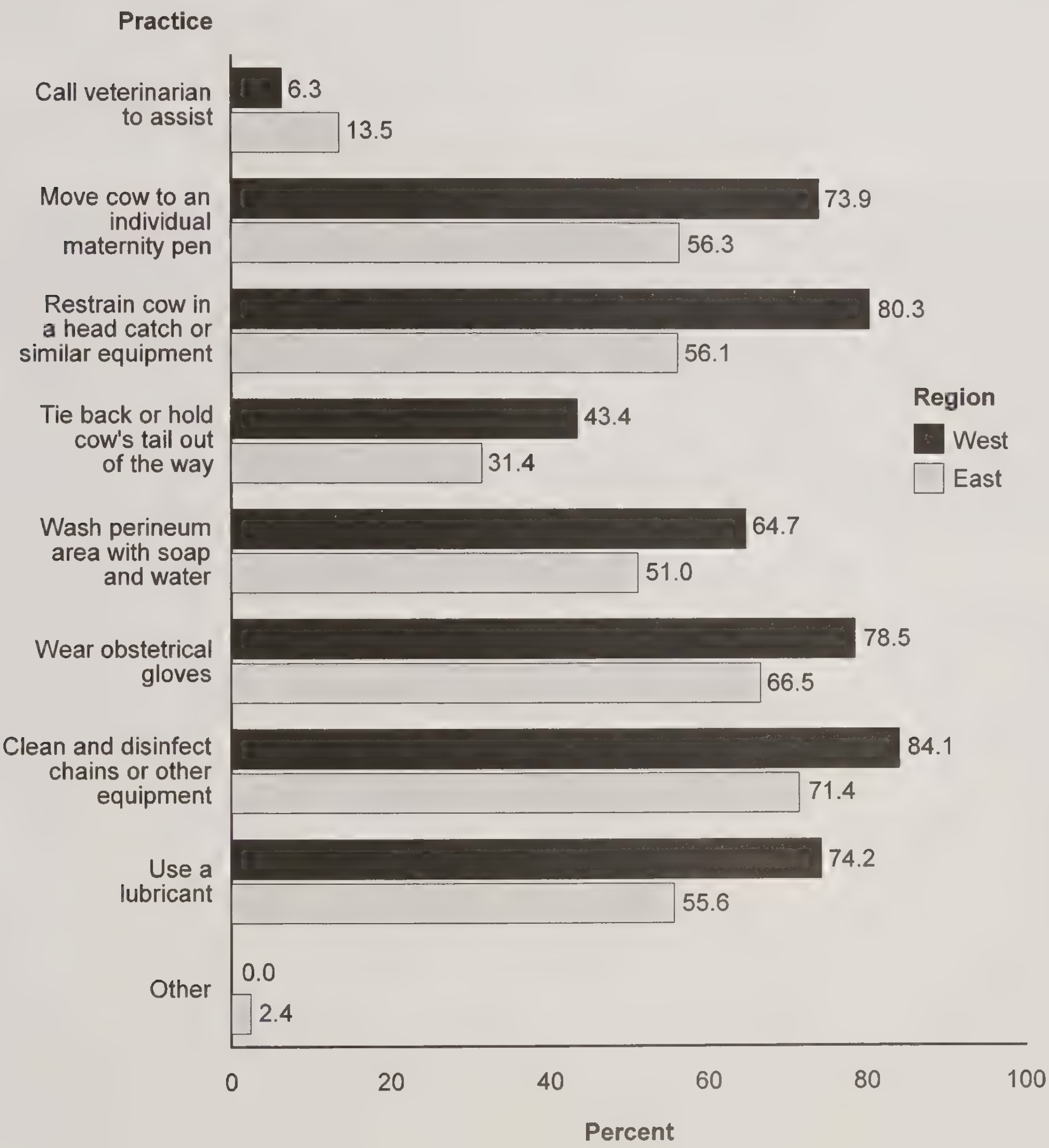
	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Practice	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Call veterinarian to assist	14.6	(3.1)	10.6	(2.9)	3.6	(2.1)	12.9	(2.3)
Move cow to an individual maternity pen	54.4	(4.0)	64.4	(4.1)	69.0	(5.5)	57.8	(2.9)
Restrain cow in a head catch or similar equipment	55.1	(4.0)	58.4	(4.3)	91.7	(2.4)	58.3	(2.9)
Tie back or hold cow's tail out of the way	30.3	(3.7)	36.0	(4.3)	41.2	(6.3)	32.4	(2.8)
Wash perineum area with soap and water	48.8	(4.1)	55.9	(4.5)	74.8	(5.4)	52.2	(3.0)
Wear obstetrical gloves	62.5	(4.0)	76.2	(3.5)	87.1	(4.3)	67.5	(2.9)
Clean and disinfect chains or other equipment prior to use in the vagina or uterus	70.4	(3.7)	75.2	(4.0)	85.7	(4.5)	72.6	(2.7)
Use a lubricant	50.4	(4.1)	69.5	(4.1)	82.2	(5.1)	57.2	(3.0)
Other	3.0	(1.4)	0.3	(0.3)	0.3	(0.3)	2.2	(0.9)

The use of three recommended practices for calving interventions differed by region: a higher percentage of operations in the West region than in the East region would generally move the cow to an individual maternity pen (73.9 and 56.3 percent, respectively), restrain the cow in a head catch or similar equipment (80.3 and 56.1 percent, respectively), or use a lubricant (74.2 and 55.6 percent, respectively).

b. Percentage of operations by practice generally implemented once a decision is made to intervene in calving, by region

	Percent Operations			
	Region			
	West		East	
Practice	Percent	Std. Error	Percent	Std. Error
Call veterinarian to assist	6.3	(2.4)	13.5	(2.5)
Move cow to an individual maternity pen	73.9	(5.1)	56.3	(3.2)
Restrain cow in a head catch or similar equipment	80.3	(3.7)	56.1	(3.2)
Tie back or hold cow's tail out of the way	43.4	(5.6)	31.4	(3.0)
Wash perineum area with soap and water	64.7	(5.8)	51.0	(3.3)
Wear obstetrical gloves	78.5	(5.0)	66.5	(3.1)
Clean and disinfect chains or other equipment prior to use in the vagina or uterus	84.1	(4.3)	71.4	(2.9)
Use a lubricant	74.2	(5.2)	55.6	(3.2)
Other	0.0	(--)	2.4	(1.0)

Percentage of Operations by Practice Generally Implemented Once a Decision is Made to Intervene in Calving, by Region



Although the dam provides the best lubricant, additional lubricant during dystocia can be helpful in delivering a healthy calf and in protecting the dam from trauma. With the exception of water used alone, all lubricants listed below may be helpful. The best choice is a commercial obstetrical lubricant mixed with water and used generously.

More than 50 percent of operations that generally used a lubricant during calving intervention used a commercial lubricant (57.5 percent), soap (56.2 percent), or water with other lubricant (51.8 percent). Less than 10 percent of operations used mineral oil, shortening, or water only as a lubricant.

c. For the 57.2 percent of operations that generally used a lubricant during calving intervention, percentage of operations by type of lubricant used

Lubricant	Percent Operations	Standard Error
Mineral oil	8.4	(1.8)
Soap	56.2	(3.6)
Water with other lubricant	51.8	(3.8)
Water only	2.0	(1.1)
Commercial obstetrical lubricant (e.g., J-Lube)	57.5	(3.8)
Shortening (e.g., Crisco)	2.4	(1.1)
Other	1.0	(0.5)

Instruments used to assist with a difficult delivery should be easy to sanitize, especially those used inside the vagina and uterus. Most operations (71.1 percent) used stainless-steel OB chains for pulling calves; these chains are easy to sanitize and are recommended for use. Stainless-steel OB chains were used on a higher percentage of medium and large operations than on small operations. Alternatively, twine was used on a higher percentage of small operations than medium or large operations. Almost 50 percent of operations (49.6 percent) used twine to pull calves, while 22.1 percent used rope.

d. Percentage of operations by type of equipment used for pulling calves (direct contact with calf), and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Equipment Type	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Stainless-steel OB chains	65.5	(3.8)	81.5	(3.7)	90.6	(3.5)	71.1	(2.8)
Twine	56.5	(4.0)	37.7	(4.4)	21.5	(5.4)	49.6	(3.0)
Rope	23.2	(3.5)	19.4	(3.5)	21.4	(5.3)	22.1	(2.6)
Other	3.1	(1.3)	1.7	(0.7)	8.1	(3.5)	3.1	(0.9)
Any	99.4	(0.6)	100.0	(0.0)	100.0	(0.0)	99.6	(0.4)

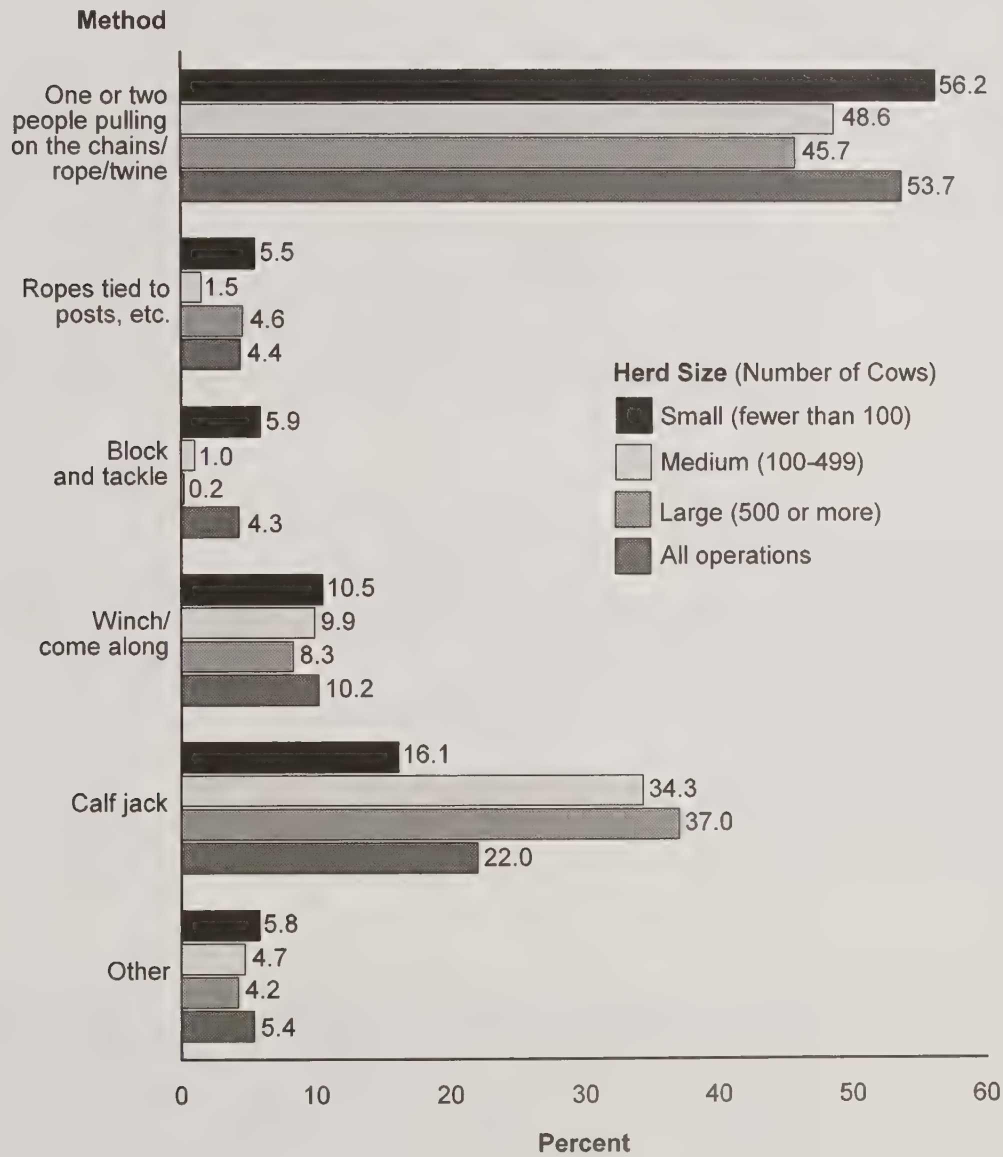
Pressure exerted on the calf during an assisted delivery can cause injury or death to the cow and calf. Studies have reported that two strong people can exert a force of 400 to 600 pounds while delivering a calf, whereas a calf jack can exert 2,000 pounds of force. If two people cannot deliver a calf manually, then an alternative delivery methods, such as a C-section for live calves or a fetotomy for dead calves, are usually recommended.

More than one-half of operations (53.7 percent) reported that one or two people pulling on the chains, rope, or twine was the method most commonly used to apply traction to deliver the calf. About one of five operations (22.0 percent) used a calf jack to apply traction. A block and tackle was used by a higher percentage of small operations than large operations (5.9 and 0.2 percent, respectively). A higher percentage of medium and large operations used a calf jack (34.3 and 37.0 percent, respectively) compared with small operations (16.1 percent).

e. Percentage of operations by method most commonly used to apply traction to deliver the calf, and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Method	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
One or two people pulling on the chains/rope/twine	56.2	(4.0)	48.6	(4.4)	45.7	(6.3)	53.7	(3.0)
Ropes tied to posts, etc.	5.5	(2.1)	1.5	(0.8)	4.6	(2.4)	4.4	(1.4)
Block and tackle	5.9	(1.8)	1.0	(0.9)	0.2	(0.2)	4.3	(1.3)
Winch/come-along	10.5	(2.7)	9.9	(2.6)	8.3	(3.3)	10.2	(2.0)
Calf jack	16.1	(2.8)	34.3	(4.1)	37.0	(5.9)	22.0	(2.2)
Other	5.8	(1.8)	4.7	(1.7)	4.2	(3.7)	5.4	(1.3)
Total	100.0		100.0		100.0		100.0	

Percentage of Operations by Method Most Commonly Used to Apply Traction to Deliver the Calf, and by Herd Size



To reduce the possibility of injury to the dam during calving intervention, traction should be applied when the dam is straining. More than three of four operations (77.3 percent) generally applied traction in conjunction with the dam straining, while 22.7 percent generally applied traction continuously.

f. Percentage of operations by best description of how traction is generally applied during calving intervention, and by region

	Percent Operations					
	Region					
	West		East		All Operations	
Traction Application	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
In conjunction with dam straining	88.2	(3.5)	76.2	(2.7)	77.3	(2.5)
Continuously	11.8	(3.5)	23.8	(2.7)	22.7	(2.5)
Total	100.0		100.0		100.0	

7. Veterinary assistance

Although only 12.9 percent of operations would generally seek veterinary assistance immediately after making the decision to intervene during calving, (see table a., p 35), almost all operations had sought veterinary assistance for difficult deliveries, regardless of herd size or region.

a. Percentage of operations that seek veterinary assistance for difficult deliveries, and by herd size

Percent Operations							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
95.5	(1.5)	95.0	(1.5)	86.8	(4.4)	94.8	(1.1)

b. Percentage of operations that seek veterinary assistance for difficult deliveries, by region

Percent Operations			
Region			
West		East	
Percent	Standard Error	Percent	Standard Error
86.6	(3.9)	95.6	(1.2)

For the 94.8 percent of operations that seek veterinary assistance for difficult deliveries, 93.5 percent would seek assistance to help correct the calf's position for delivery, and 85.6 percent would seek veterinary assistance after applying traction for a specific amount of time with no evidence of progress.

c. For the 94.8 percent of operations that seek veterinary assistance for difficult deliveries, percentage of operations that would seek assistance for the following situations, by region

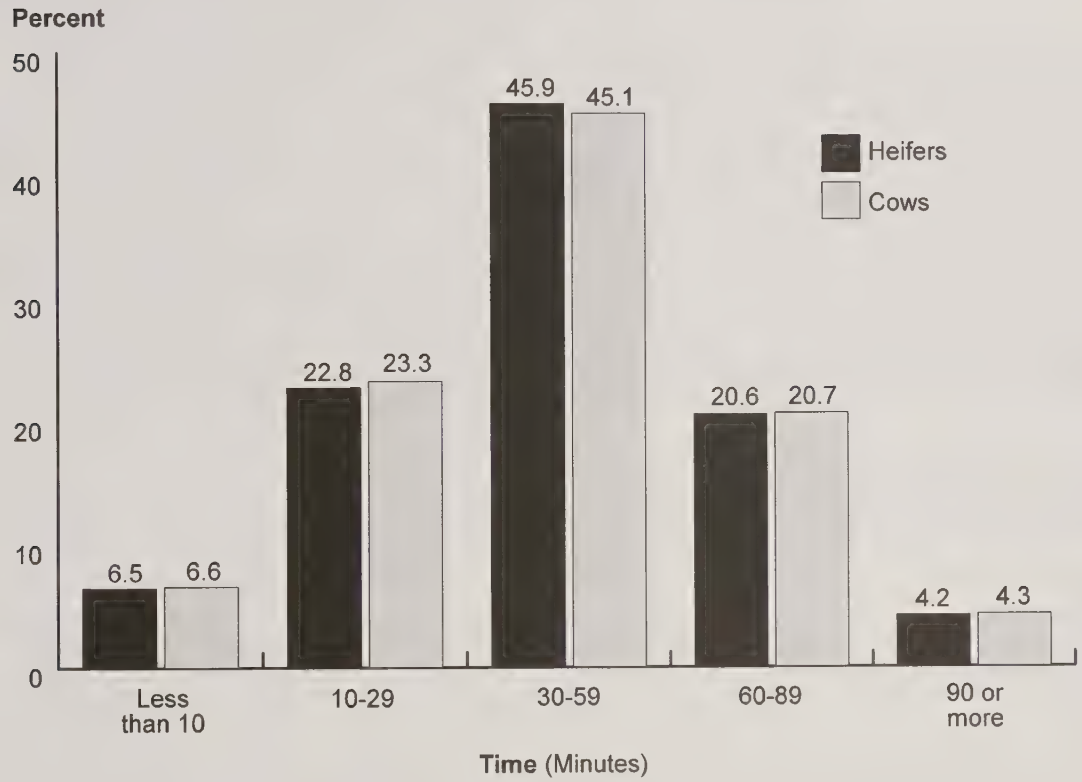
	Percent Operations					
	Region					
	West		East		All Operations	
Situation	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Unable to correctly position calf for delivery	87.5	(4.5)	94.0	(1.5)	93.5	(1.4)
Applied traction for a specific amount of time without progress	81.3	(4.7)	86.0	(2.4)	85.6	(2.2)

The percentages of operations by length of time elapsed before calling for assistance were about the same for heifers and cows. About 30 percent of operations would call for veterinary assistance within 30 minutes of intervening in a calving. The highest single percentages of operations would seek assistance within 30 to 59 minutes of intervening for both heifers and cows. About one-fourth of operations (24.8 percent for heifers and 25.0 percent for cows) would work to relieve the dystocia for 1 hour or more before calling for veterinary assistance.

d. For the 94.8 percent of operations that seek veterinary assistance for difficult deliveries, percentage of operations by length of time from beginning intervention during calving until calling for veterinary assistance, for heifers and for cows

	Percent Operations			
	Heifers		Cows	
Time (Minutes)	**Percent**	**Std. Error**	**Percent**	**Std. Error**
Less than 10	6.5	(1.5)	6.6	(1.5)
10 to 29	22.8	(2.7)	23.3	(2.7)
30 to 59	45.9	(3.2)	45.1	(3.2)
60 to 89	20.6	(2.5)	20.7	(2.5)
90 or more	4.2	(1.1)	4.3	(1.1)
Total	100.0		100.0	

For the 94.8 Percent of Operations that Ever Seek Veterinary Assistance for Difficult Deliveries, Percentage of Operations by Length of Time from Beginning Intervention During Calving Until Calling for Veterinary Assistance, for Heifers and for Cows



A higher percentage of cows (79.4 percent) than heifers (69.0 percent) calved unassisted during the previous 12 months. A higher percentage of heifers than cows experienced severe dystocia (6.8 percent of heifers and 3.5 percent of cows) or mild dystocia (11.8 percent of heifers and 7.3 percent of cows).

e. Percentage of heifers and cows that calved during the previous 12 months, by calving difficulty

Calving Difficulty	Percent Heifers[1]	Std. Error	Percent Cows[2]	Std. Error
Severe dystocia (surgical or mechanical extraction)	6.8	(0.7)	3.5	(0.3)
Mild dystocia	11.8	(0.8)	7.3	(0.5)
No dystocia, but assistance provided anyway	12.4	(1.0)	9.8	(0.9)
No assistance	69.0	(1.4)	79.4	(1.3)
Total	100.0		100.0	

[1]As a percentage of dairy cow replacements entering the milking herd in 2006.
[2]As a percentage of cows on the operation at the time of VS Initial Visit interview.

8. Assistance for compromised calves

Calves that experience a dystocia are more likely to be stillborn. Calves that experience a dystocia but are born alive can be given assistance, such as supplemental oxygen, which increases their chances of survival. Depending on the environmental conditions, all the procedures listed in the following table—with the exception of hanging calves upside down—are considered beneficial to the health of the calves when administered correctly. Hanging calves upside down, which was once promoted to assist in removing fluid from the calves' lungs, might actually be harmful for two reasons: most of the liquid comes from the abomasum and not the lungs, making the calves more susceptible to dehydration; and hanging the calves upside down increases pressure on the chest, making it more difficult for the calves to breathe. Calves that experience dystocia are likely to have low levels of oxygen in their blood (hypoxia), and their blood pH is frequently acidic (acidosis) instead of neutral. These impairments lead to other problems, such as decreased ability to nurse and decreased absorption of IgG, and can negatively impact temperature regulation. In many cases, the administration of oxygen to calves after dystocia may have the single largest impact on calf survival.

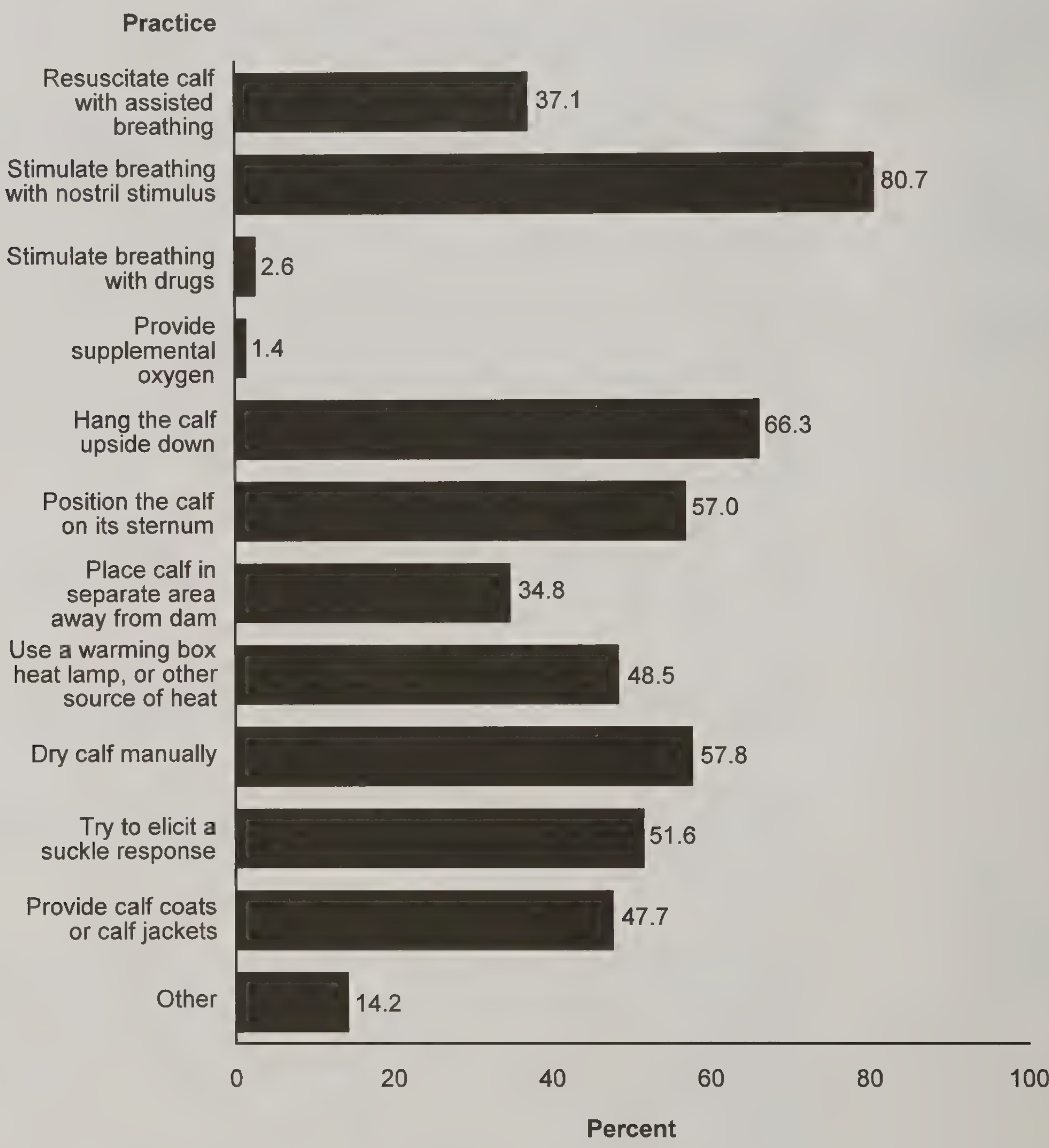
On 80.7 percent of operations, calves that experienced a difficult birth would receive nostril stimulation to initiate breathing. Hanging calves upside down would be performed on 66.3 percent of operations. Three practices which are simple to perform and do not require special equipment or materials were performed by at least one-half of operations: positioning the calf on its sternum, drying the calf manually with towels or a hair dryer, and trying to elicit a suckle response. Few operations (1.4 percent) would provide supplemental oxygen. "Other" practices included allowing the dam to lick/ stimulate the calf and feeding colostrum (14.2 percent of operations).

The use of some practices varied by size of operation. Almost two-thirds of large operations (62.5 percent) resuscitated calves via assisted breathing, compared with slightly more than one-third of small and medium operations (35.0 and 36.6 percent, respectively). A higher percentage of small and medium operations (61.5 and 55.6 percent, respectively) than large operations (27.4 percent) dried calves manually with towels, hair dryer, etc. Additionally, a higher percentage of small and medium operations (45.8 and 58.5 percent, respectively) provided calf coats or calf jackets compared with large operations (26.6 percent).

a. Percentage of operations by practice generally done within 1 hour after delivery for a calf that experienced a difficult birth, and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Practice	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Resuscitate calf with assisted breathing	35.0	(3.9)	36.6	(4.3)	62.5	(5.9)	37.1	(2.9)
Stimulate breathing with nostril stimulus	77.3	(3.4)	88.3	(2.7)	87.7	(4.2)	80.7	(2.5)
Stimulate breathing with drugs (Dopram, etc.)	0.6	(0.5)	6.7	(2.4)	7.9	(3.4)	2.6	(0.7)
Provide supplemental oxygen	0.0	(--)	5.2	(2.2)	2.3	(2.1)	1.4	(0.6)
Hang the calf upside down	66.3	(3.8)	66.2	(4.3)	67.0	(6.0)	66.3	(2.8)
Position the calf on its sternum	54.3	(4.0)	63.4	(4.4)	61.2	(6.2)	57.0	(3.0)
Place the calf in separate area away from the dam	32.6	(3.8)	39.1	(4.5)	41.5	(6.0)	34.8	(2.9)
Use a warming box, heat lamp, or other source of heat during cold weather	45.7	(4.1)	59.3	(4.4)	36.6	(5.0)	48.5	(3.0)
Dry calf manually with towels, hair dryer, etc.	61.5	(3.8)	55.6	(4.5)	27.4	(5.3)	57.8	(2.8)
Try to elicit a suckle response	53.9	(4.0)	48.6	(4.4)	39.2	(6.4)	51.6	(3.0)
Provide calf coats or calf jackets after calf is dry	45.8	(4.1)	58.5	(4.3)	26.6	(4.9)	47.7	(3.0)
Other	16.9	(3.2)	7.7	(2.8)	10.7	(4.1)	14.2	(2.4)

Percentage of Operations by Practice Generally Done Within 1 Hour After Delivery for a Calf that Experienced a Difficult Birth



A higher percentage of operations in the West region (54.3 percent) generally resuscitated calves that experienced a difficult birth with assisted breathing compared with operations in the East region (35.5 percent). Alternatively, a higher percentage of operations in the East region dried calves manually with towels, hair dryer, etc. (60.1 percent) or provided calf coats or jackets after the calves were dry (50.5 percent), compared with 34.5 and 18.7 percent of operations in the West region, respectively.

b. Percentage of operations by practice generally done within 1 hour after delivery for a calf that experienced a difficult birth, by region

	Percent Operations			
	Region			
	West		East	
Practice	Percent	Std. Error	Percent	Std. Error
Resuscitate calf with assisted breathing	54.3	(5.4)	35.5	(3.1)
Stimulate breathing with nostril stimulus	84.1	(4.1)	80.4	(2.7)
Stimulate breathing with drugs (Dopram, etc.)	2.5	(1.4)	2.6	(0.8)
Provide supplemental oxygen	3.3	(2.0)	1.3	(0.6)
Hang the calf upside down	67.0	(5.9)	66.3	(3.1)
Position the calf on its sternum	60.2	(6.0)	56.7	(3.2)
Place the calf in separate area away from the dam	34.6	(5.9)	34.8	(3.1)
Use a warming box, heat lamp, or other source of heat during cold weather	38.7	(5.5)	49.4	(3.3)
Dry calf manually with towels, hair dryer, etc.	34.5	(5.5)	60.1	(3.0)
Try to elicit a suckle response	37.6	(5.7)	53.0	(3.2)
Provide calf coats or calf jackets after calf is dry	18.7	(4.4)	50.5	(3.3)
Other	6.5	(2.7)	15.0	(2.6)

C. Colostrum Management and Passive Transfer Status

Note: Unless otherwise specified, estimates in the following tables represent only operations with 30 or more dairy cows.

1. Colostrum management

Providing high quality colostrum as soon as possible after birth maximizes dairy calf health. Colostrum is produced in the 5 weeks prior to calving and differs from milk in that it contains higher levels of protein (especially immunoglobulins), fat, and fat soluble vitamins like vitamin A (Davis and Drackley, 1998). Colostrum is harvested during the first milking after calving. Milk produced in the interim (e.g., second and third milking) between the harvest of colostrum and normal (saleable) milk is commonly referred to as transition milk.

a. Comparison of colostrum, transition milk, and saleable milk by content parameter

		Transition Milk		
Parameter	Colostrum	Second Milking	Third Milking	Saleable Milk
Specific gravity	1.056	1.040	1.035	1.032
IgG (g/100 mL)	4.1	2.5	1.5	0.06
Fat (percent)	6.7	5.4	3.9	3.6
Total protein (percent)	14.9	8.4	5.1	3.2
Lactose (percent)	2.5	3.9	4.4	4.9
Vitamin A (µg/g)	4.9	1.8	1.1	0.3

Source: adapted from Foley and Otterby (1978), Davis and Drackley (1998), and Kehoe et al. (2007).

Colostrum is critically important to calves because calves are born with little or no previous exposure to infectious pathogens. All mammals need maternal immunoglobulins to be protected from disease following birth, and most animals receive the immunoglobulins *in utero* across the placenta. In contrast, calves are born with no immunoglobulins, so they rely on the ingestion of colostrum. The process by which the cow passes immunoglobulins to the calf via colostrum is called passive transfer of immunity. Successful passive transfer in calves is important to dairy producers for a number of reasons. Studies have shown that failure of passive transfer in heifers increases calf morbidity and mortality, reduces calf growth rate and efficiency, and decreases first and second lactation milk production (Fahey and McKelvey, 1965; Faber et al., 2005; Wells et al., 1996).

There are four key principals to colostrum management on the dairy farm: **quality**, **quantity**, **quickness**, and **cleanliness** (Stewart et al., 2005).

Colostrum **quality** refers to the concentration of immunoglobulins in the colostrum, and the goal is to have greater than 50 g IgG/L. Colostrum

quality is highly variable; values for Holstein cattle have been reported between 9.4 and 185.7 g IgG/L (Burton et al., 1989; Levieux and Oliver, 1999; Tyler et al., 1999; Morin et al., 2001; Swan et al., 2007). Colostrum quality can be affected by cattle breed, parity (primiparous versus multiparous), length of the dry period, vaccination history of the dam, and timing of colostrum collection after calving. To obtain high quality colostrum, the cow should be milked as soon as possible after calving, preferably within 1 to 2 hours, and no later than 6 hours (Godden, 2008). The amount of IgG in colostrum decreases when first milking is delayed. By 6 hours after calving, the immunoglobulin concentration in colostrum can drop by 17 percent when compared with the levels 2 hours after calving (Moore et al., 2005). Producers can also improve the quality of colostrum by ensuring good dry cow nutrition and comfort, avoiding long or short dry periods, and by having a regular vaccination program for dry cows and heifers.

Common methods for assessing colostrum quality on the farm include visual inspection and the use of a colostrometer. The colostrometer (hydrometer) provides an estimate of IgG levels based on the specific gravity of the colostrum. Although the colostrometer has poor sensitivity for predicting colostrum quality (Pritchett et al., 1994), it is still the most common method used on dairies because it is economical and simple. Colostrum should be at room temperature when using a colostrometer, and only high quality (green) colostrum should be fed to newborn calves. Fair and poor quality colostrum can be fed to calves 24 hours of age and older for nutritional purposes rather than for acquiring immunity. Another method for determining colostrum quality is to directly measure the IgG concentration, either with an available field test kit (Chigerwe et al., 2005) or by sending a sample to a laboratory. Visual inspection is not an accurate method for ascertaining the IgG content of colostrum, but it is important in determining whether colostrum contains blood or is mastitic and, therefore, should not be fed to calves.

It is important to feed an adequate **quantity** of colosturm to calves, once it is determined that the colostrum is of high quality. The Bovine Alliance on Management and Nutrition's "Guide to Colostrum and Colostrum Management for Dairy Calves" suggests that 4 quarts of high quality colostrum should be fed by esophageal feeder within 1 hour of birth (BAMN, 2001). This recommendation applies for the average 90-pound Holstein calf. A larger calf will need a larger volume of colostrum, and a small calf, such as a Jersey or Guernsey, may only need 3 quarts. Colostrum can be hand-fed with either a bottle or an esophageal tube. Passive transfer can be achieved with either method, as long as an adequate volume (4 quarts) of colostrum is fed (Molla, 1978; Adams et al., 1985; Besser et al., 1991). Leaving the calf with the cow for nursing is not recommended because 61 percent (Besser et al., 1991) or 42 percent (Brignole and Stott, 1980) of these calves may not receive adequate passive transfer of immunity. Also, calves allowed to nurse have an increased risk of exposure to pathogens because they may ingest manure from the environment while searching for and suckling teats.

Quickness is another important factor in colostrum management. At birth, a calf's gastrointestinal system is designed to temporarily allow the absorption of large molecules, allowing the IgG in colostrum to be absorbed into the bloodstream. The ability of the calf to absorb the immunoglobulins decreases with time and is typically gone within 24 hours after birth (Stott et al., 1979). A study showed that in a small group of calves allowed to nurse the dam, calf serum IgG levels decreased by 2 mg/mL for every 30-minute delay in the ingestion of colostrum (Rajala and Castren, 1995). Therefore, it is recommended that the calf receive colostrum as soon as possible following birth, preferably within 1 hour and no later than 6 hours.

Cleanliness is also important to a successful colostrum management program. Bacteria in colostrum such as *E coli*, *Salmonella, Mycoplasma,* and *Mycobacterium avium* subspecies *paratuberculosis*, can cause diseases in calves. The cleanliness of colostrum can be assessed by submitting a sample for bacteriological culture. The results of the culture are reported as total plate count (TPC), which reflects the total number of aerobic bacteria in the sample, and total coliform count, which indicates the level of contamination of the sample by gram-negative aerobic bacteria typically found in the intestinal tract of animals, such as *E. coli*. Each live bacterium in the colostrum sample represents a colony forming unit (cfu). The goal for colostrum cleanliness is to have a TPC less than 100,000 cfu/mL, and total coliform count less than 10,000 cfu/mL (McGuirk and Collins, 2004). Bacterial contamination of colostrum may be a common problem on dairies; TPC and total coliform counts exceeded 100,000 cfu/mL and 10,000 cfu/mL, respectively, in 85 percent of colostrum samples from 40 different farms (McGuirk and Collins, 2004).

Proper collection, handling, and storage will reduce the number of bacteria in colostrum. Prior to colostrum collection, the udder should be cleaned and prepared in the same manner used for collecting saleable milk. In addition, equipment used for milking, storing colostrum, and feeding calves should be sanitized regularly. Studies have shown that storing colostrum at warm ambient temperatures results in a rapid increase of bacterial growth (Stewart et al., 2005). To minimize bacterial growth, colostrum should be fed within 1 hour of collection; if it is not to be fed within 1 hour of collection, it can be refrigerated in 2-quart plastic containers for up to 24 hours. For storage longer than 24 hours, colostrum can be frozen in plastic freezer bags for up to 1 year, as long as it is not repeatedly thawed and refrozen. Freezing will not reduce the IgG levels or nutrient content in colostrum (Foley and Otterby, 1978; Klobasa et al., 1998). However, one study reported that calves fed previously frozen colostrum were at a slightly higher risk for failure of passive transfer than calves fed refrigerated colostrum (Besser et al., 1991).

Unpasteurized colostrum should not be pooled, as this practice can increase calves' exposure to pathogens. For example, if a single cow in the herd has Johne's disease, pooling colostrum could potentially expose multiple calves to the

disease. It has also been suggested that pooling colostrum decreases the rate of successful passive transfer of immunity (Weaver et al., 2000), probably because the immunoglobulins in the pooled colostrum are diluted by samples with high volume but low immunoglobulin levels.

More than one-half of operations (55.9 percent) removed newborn heifer calves immediately after calving, prior to nursing. These operations accounted for 65.6 percent of all heifer calves. One of five operations (22.2 percent) —accounting for 21.3 percent of newborn calves—removed calves after they nursed their dams but prior to 12 hours of age. Fewer than 1 of 10 operations (7.3 percent)—representing 2.6 percent of calves—allowed calves to stay with their dams for more than 24 hours.

b. Percentage of operations (and percentage of heifers born on these operations during 2006 and alive at 48 hours) by time following birth that calves were normally separated from their dams

Time	Percent Operations[1]	Standard Error	Percent Heifer Calves[2]	Standard Error
Immediately (no nursing)	55.9	(1.4)	65.6	(1.5)
After nursing but less than 12 hours	22.2	(1.2)	21.3	(1.3)
12 to 24 hours	14.6	(1.0)	10.5	(0.9)
More than 24 hours	7.3	(0.8)	2.6	(0.3)
Total	100.0		100.0	

[1]Operations with any dairy cows.
[2]Born during 2006 and alive at 48 hours.

On average, calves received hand-fed colostrum 3.3 hours following birth.

c. For the 55.9 percent of operations that immediately removed calves from their dams and hand-fed colostrum, operation average number of hours after birth that calves got their first colostrum feeding, and by herd size

Operation Average Hours*							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Hours	Std. Error	Hours	Std. Error	Hours	Std. Error	Hours	Std. Error
3.4	(0.1)	3.3	(0.1)	2.8	(0.2)	3.3	(0.1)

*Operations with any dairy cows.

The majority of operations (59.2 percent) hand-fed colostrum to calves from a bucket or bottle. These operations accounted for 59.6 percent of heifer calves. About one-third of operations (36.3 percent) allowed calves to ingest colostrum during first nursing of the dam. A total of 4.3 percent of operations accounting for 13.7 percent of calves used an esophageal feeder to administer colostrum.

d. Percentage of operations (and percentage of heifers born on these operations during 2006 and alive at 48 hours) by method normally used for calves' first feeding of colostrum

Colostrum Delivery Method	Percent Operations[1]	Std. Error	Percent Heifer Calves[2]	Std. Error
During first nursing of dam	36.3	(1.4)	26.5	(1.3)
Hand-fed from bucket or bottle	59.2	(1.4)	59.6	(1.6)
Hand-fed using esophageal feeder	4.3	(0.5)	13.7	(1.2)
Did not get colostrum	0.2	(0.1)	0.2	(0.1)
Total	100.0		100.0	

[1]Operations with any dairy cows.
[2]Born during 2006 and alive at 48 hours.

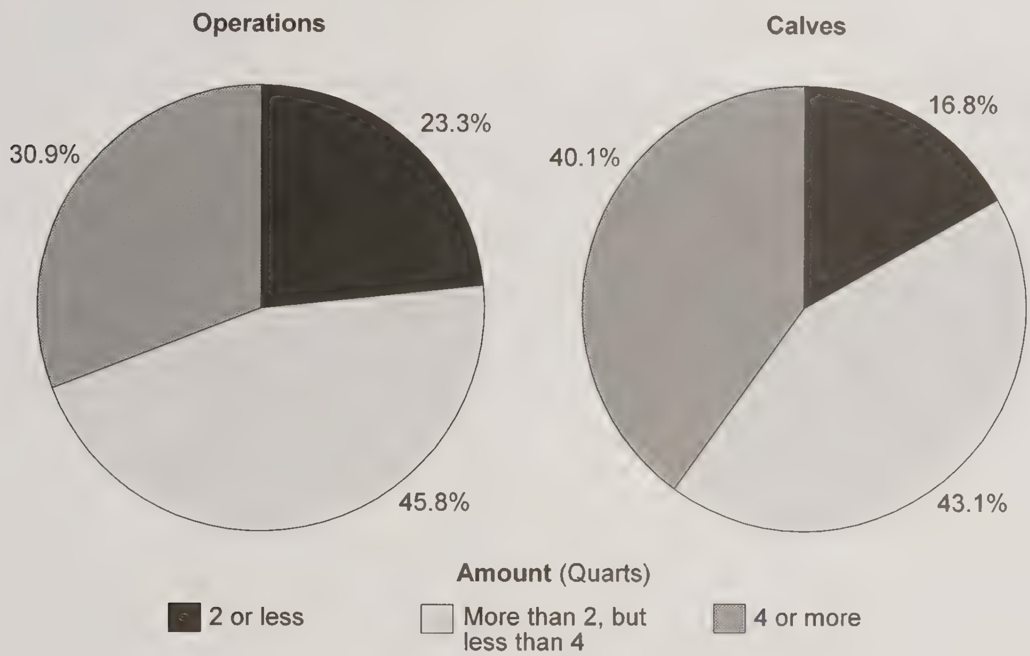
Of operations that normally hand-fed colostrum, 45.8 percent—representing 43.1 percent of heifer calves—fed calves more than 2 but less than 4 quarts of colostrum during the first 24 hours of life. About 4 of 10 calves (40.1 percent) received 4 quarts or more, while 16.8 percent received 2 quarts or less during the first 24 hours.

e. For the 63.5 percent of operations that normally hand-fed colostrum, percentage of operations (and percentage of heifers born on these operations during 2006 and alive at 48 hours) by amount of colostrum normally fed during the first 24 hours

Amount (Quarts)	Percent Operations[1]	Std. Error	Percent Heifer Calves[2]	Std. Error
2 or less	23.3	(1.6)	16.8	(1.4)
More than 2 but less than 4	45.8	(1.9)	43.1	(2.1)
4 or more	30.9	(1.7)	40.1	(2.0)
Total	100.0		100.0	

[1]Operations with any dairy cows.
[2]Born during 2006 and alive at 48 hours.

For the 63.5 Percent of Operations that Normally Hand-Fed Colostrum, Percentage of Operations (and Percentage of Heifer Calves Born and Alive at 48 Hours on These Operations During 2006) by Amount of Colostrum Normally Fed During the First 24 Hours



About one of eight operations that hand-fed colostrum (13.0 percent) estimated the immunoglobulin levels of the colostrum or evaluated its quality before feeding. The percentage of operations that evaluated colostrum more than doubled as herd size increased, ranging from 7.6 percent of small operations to 45.2 percent of large operations.

f. For the 63.5 percent of operations that normally hand-fed colostrum, percentage of operations that estimated the immunoglobulin levels of the colostrum or evaluated its quality, by herd size

Percent Operations*							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
7.6	(1.3)	19.8	(2.3)	45.2	(3.2)	13.0	(1.1)

*Operations with any dairy cows.

The most commonly used methods of evaluating colostrum were a colostrometer and visual appearance (43.7 and 41.6 percent of operations, respectively).

g. For the 13.0 percent of operations that estimated immunoglobulin levels in colostrum or evaluated its quality, percentage of operations by primary method used for measuring immunoglobulin

Primary Method	Percent Operations*	Standard Error
Colostrometer	43.7	(4.2)
Visual appearance	41.6	(4.3)
Volume of first milking colostrum (lb)	9.7	(2.8)
Other	5.0	(2.7)
Total	100.0	

*Operations with any dairy cows.

The majority of small operations (64.8 percent) did not store colostrum. In comparison, only 11.8 percent of large operations did not store colostrum. For large operations that stored colostrum, 50.5 percent used a refrigerator as the primary method of storage and 34.7 percent used a freezer.

h. For the 63.5 percent of operations that normally hand-fed colostrum, percentage of operations by primary method of storing colostrum, and by herd size

	Percent Operations[1]							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Primary Method[2]	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Stored without refrigeration	4.4	(1.0)	2.8	(0.9)	3.0	(0.9)	3.9	(0.7)
Stored in refrigerator	6.0	(1.1)	15.2	(1.9)	50.5	(3.5)	11.1	(0.9)
Stored in freezer	24.8	(2.1)	36.2	(2.8)	34.7	(3.0)	28.2	(1.6)
Not stored	64.8	(2.3)	45.8	(3.0)	11.8	(2.8)	56.8	(1.8)
Total	100.0		100.0		100.0		100.0	

[1]Operations with any dairy cows.
[2]No operations reported “other” as a primary method for storing colostrum.

About one of five operations (21.0 percent) pooled colostrum. As herd size increased so did the percentage of operations that pooled colostrum, ranging from 16.0 percent of small operations to 56.9 percent of large operations.

i. For the 63.5 percent of operations that normally hand-fed colostrum, percentage of operations that pooled colostrum from more than one cow, by herd size

Percent Operations*

Herd Size (Number of Cows)

Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
16.0	(1.7)	26.0	(2.4)	56.9	(3.1)	21.0	(1.3)

*Operations with any dairy cows.

A Johne's disease control program may include testing individual animals in order to identify those shedding *Mycobacterium avium* subspecies *paratuberculosis* and, therefore, presenting a risk to noninfected animals on the operation. More than one-third of operations (35.3 percent) tested for Johne's disease. A higher percentage of medium operations than small operations tested for Johne's disease (47.6 and 30.7 percent, respectively).

j. Percentage of operations that tested for Johne's disease, by herd size

Percent Operations

Herd Size (Number of Cows)

Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
30.7	(3.4)	47.6	(4.1)	37.5	(5.7)	35.3	(2.6)

Colostrum from Johne's test-positive cows could transmit the disease to calves. Studies suggest that colostrum is approximately three times as likely as milk to contain *Mycobacterium avium* subspecies *paratuberculosis* (Streeter, 1995). Operations should use colostrum from test-negative cows, pasteurize colostrum prior to feeding, or feed a commercial colostrum replacer. About 1 of 20 operations that tested for Johne's disease (4.9 percent) fed colostrum from test-positive cows to calves. There were no differences by herd size.

k. For the 35.3 percent of operations that tested for Johne's disease, percentage of operations in which calves were fed colostrum from cows that tested positive for Johne's disease, by herd size

Percent Operations

Herd Size (Number of Cows)

Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
6.0	(2.9)	3.8	(2.8)	0.6	(0.4)	4.9	(2.0)

2. Pasteurizing colostrum

Pasteurizing colostrum significantly reduces or eliminates pathogens and reduces the potential for transmitting disease to calves. Colostrum should not be pasteurized at the same times and temperatures used to pasteurize milk (high temperature short time—161 °F (71 °C) for 15 seconds, or Holder Method—145 °F (63 °C) for 30 minutes). At these times and temperatures colostrum will thicken and its immunoglobulin levels will decrease significantly (Meylan et al., 1996; Godden et al., 2003; Stabel et al., 2004). For colostrum, batch pasteurization at 140 °F (60 °C) for 60 minutes decreased bacterial counts without decreasing immunoglobulin levels (Godden et al., 2006). Calves fed colostrum pasteurized in this manner had improved immunoglobulin absorption, possibly due to decreased bacterial interference with passive transfer (Johnson et al., 2007).

It is important to note that pasteurization will not increase the amount of maternal antibodies in the colostrum. Although pasteurization is commonly used for milk and works well for colostrum, there are several technical issues inherent in pasteurizing colostrum.

If colostrum is pasteurized, the following management practices are recommended:

1. Use a batch pasteurizer
2. Treat small batches (15-gallon maxium)
3. Ensure precise temperature control (do not allow temperature to rise above 140^{0}F)
4. Agitate constantly during heat-up, pasteurization, and cool-down phases
5. Rapidly heat and cool colostrum
6. Maintain and clean equipment regularly

7. Monitor serum IgG or protein levels and culture colostrum samples to verify that the system is working (Godden et al., 2007).

These intensive managing and monitoring requirements might be one reason that relatively few dairies pasteurize colostrum.

Less than 1 percent of operations that hand-fed colostrum (0.8 percent) pasteurized the colostrum before feeding it to calves. A higher percentage of large operations (6.4 percent) pasteurized colostrum compared with medium and small operations (0.9 and 0.2 percent, respectively).

For the 63.5 percent of operations that normally hand-fed colostrum, percentage of operations that pasteurized colostrum, by herd size

Percent Operations*							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
0.2	(0.2)	0.9	(0.4)	6.4	(1.6)	0.8	(0.2)

*Operations with any dairy cows.

3. Measuring passive transfer of immunity

Measuring serum IgG levels or serum total protein in calves within the first week of life is a relatively simple method for evaluating passive transfer of immunity and the effectiveness of the colostrum management program. Although there are several types of immunoglobulins (IgG, IgA, IgM), IgG is the predominant immunoglobulin passed to calves via colostrum (Butler, 1983). Passive transfer of immunity is considered successful if calves' serum IgG levels are 10 mg/mL (1,000 mg/dL) or greater at 24 to 48 hours of age. Serum IgG can be measured at a laboratory using radial immunodiffusion assay (RID) (Fahey and McKelvey, 1965), and test results are generally available in 24 hours.

Serum total protein in calves can be measured as an estimate of the serum IgG level. Total protein is relatively simple and inexpensive to measure.

A serum total protein greater than or equal to 5.0 to 5.2 g/dL is correlated with successful passive transfer of immunity in healthy calves that are not dehydrated (Tyler et al., 1996). In sick calves, which are often dehydrated, a serum total protein greater than or equal to 5.5 g/dL should be used to assess passive transfer of immunity (Tyler et al., 1999). However, measuring serum total protein may not always be an accurate predictor of passive transfer on an individual-calf basis; its best application is to monitor the overall success of passive transfer in a group of calves. The goal is to have at least 90 percent of calves with serum total protein values greater than 5.2 g/dL and 50 percent above 5.5 g/dL.

Morbidity and mortality in calves is sometimes used as a measure of passive transfer success. The goal is to have morbidity affecting less than 25 percent of calves and a death rate less than 5 percent (Godden, 2007). If morbidity and mortality levels exceed these guidelines, colostrum management as well as general preweaned calf management practices should be reviewed.

Overall, 2.1 percent of operations routinely measured passive transfer via serum proteins. A higher percentage of large operations (14.5 percent) routinely evaluated passive transfer compared with medium and small operations (2.4 and 1.1 percent, respectively).

Percentage of operations that routinely monitored serum proteins (as a measure of passive transfer) in heifers within the first 3 days of life, by herd size

Percent Operations*							
Herd Size (Number of Cows)							
Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Pct.	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
1.1	(0.4)	2.4	(0.6)	14.5	(1.7)	2.1	(0.3)

*Operations with any dairy cows.

4. Calf IgG passive transfer status

The following tables on colostrum management, IgG, and total protein reflect a particular population of calves: healthy heifer calves that had received colostrum, were tested for passive transfer status, and resided on dairies with *30 or more dairy cows*. As a result, the following estimates in these tables differ from the previous tables in this report that estimated colostrum management practices for *all* heifer calves on dairy operations with at least *any* dairy cows.

As part of the Dairy 2007 study, blood samples were collected to evaluate the passive transfer status of heifer calves on U.S. dairy operations.

Healthy heifer calves that received colostrum and were 1 to 7 days old were tested for serum IgG by RID assay and total protein. For each calf tested, information was recorded about the calf's age, the quantity of colostrum the calf received at first feeding, and the method by which colostrum had been administered. A total of 1,816 samples from 394 operations in 17 States were used in the analysis.

The majority of tested calves (61.5 percent) received colostrum from a bottle. One of 10 calves received colostrum from an esophageal tube feeder or via nursing the dam. The multiple/other category includes calves fed by a bucket or pail, and calves that received colostrum in more than one way.

a. Percentage of tested heifer calves by method used for first feeding of colostrum

Colostrum Delivery Method	Percent Calves	Standard Error
Hand-fed from bottle	61.5	(3.1)
Hand-fed using esophageal tube feeder	10.3	(1.7)
Nursed dam	10.7	(1.8)
Multiple/other*	17.5	(2.7)
Total	100.0	

*Includes calves fed by buckt/pail and calves fed by more than one method, e.g., nursed dam and bottle-fed.

About one-fourth of calves (25.2 percent) were allowed to nurse from their dams. Some of these calves also received colostrum by another method. No differences were observed between the West and East regions in the percentage of heifer calves that nursed colostrum from their dams.

b. Percentage of tested heifer calves that nursed colostrum from their dams, by region

Percent Calves					
Region					
West		East		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
41.7	(9.4)	22.0	(2.8)	25.2	(2.9)

About one-half of hand-fed calves (48.5 percent) received between 2.0 and 2.9 quarts of colostrum at the first feeding, and 31.3 percent received 4.0 quarts or more.

c. For the 74.8 percent of calves not allowed to nurse their dams, percentage of tested heifer calves by amount of colostrum fed at the first feeding

Amount (Quarts)	Percent Calves	Standard Error
Less than 2.0	6.8	(1.5)
2.0 to 2.9	48.5	(3.6)
3.0 to 3.9	13.4	(2.2)
4.0 or more	31.3	(3.4)
Total	100.0	

Passive transfer status was considered excellent if serum IgG level measured by RID was 15.0 mg/mL or greater. Passive transfer was considered adequate if IgG was 10.0 to 14.9 mg/mL, and IgG less than 10.0 mg/mL was considered failure of passive transfer. The conventional phrase "failure of passive transfer" might more accurately be termed poor passive transfer, since these calves likely had some transfer of IgG. However, the conventional terminology is used in this report.

Two-thirds of calves (66.7 percent) had excellent passive transfer based on IgG levels, and about one-fifth (19.2 percent) had failure of passive transfer.

d. Percentage of tested heifer calves by IgG level and passive transfer status

IgG Level (mg/mL)	**Passive Transfer Status**	**Percent Calves**	**Standard Error**
More than 20.0	Excellent	52.4	(2.4)
15.0 to 20.0		14.3	(1.2)
10.0 to 14.9	Adequate	14.1	(1.4)
6.2 to 9.9	Failure	8.0	(0.9)
Less than 6.2		11.2	(1.2)
Total		100.0	

The percentages of tested calves with failure of passive transfer based on IgG levels were similar across herd sizes.

e. Percentage of tested heifer calves by IgG passive transfer status, and by herd size

	Percent Calves							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
IgG Passive Transfer Status	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Excellent (15.0 mg/mL or more)	65.5	(3.5)	67.8	(2.7)	68.5	(5.6)	66.7	(2.2)
Adequate (10.0-14.9 mg/mL)	15.1	(2.5)	15.0	(1.7)	9.4	(1.7)	14.1	(1.4)
Failure (Less than 10.0 mg/mL)	19.4	(2.5)	17.2	(2.2)	22.1	(4.7)	19.2	(1.7)
Total	100.0		100.0		100.0		100.0	

A higher percentage of calves in the East region than in the West region had adequate passive transfer. The percentages of calves in the excellent and failure categories were similar between the regions.

f. Percentage of tested heifer calves by IgG passive transfer status, and by region

	Percent Calves			
	Region			
	West		East	
IgG Passive Transfer Status	Percent	Std. Error	Percent	Std. Error
Excellent (15.0 mg/mL or more)	70.0	(5.8)	66.1	(2.4)
Adequate (10.0-14.9 mg/mL)	8.8	(1.7)	15.1	(1.7)
Failure (Less than 10.0 mg/mL)	21.2	(4.8)	18.8	(1.8)
Total	100.0		100.0	

Season of birth did not influence the passive transfer status of calves.

g. Percentage of tested heifer calves by IgG passive transfer status, and by season of birth

	Percent Calves					
	Season of Birth					
	Winter		Spring		Summer	
IgG Passive Transfer Status	Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
Excellent (15.0 mg/mL or more)	67.6	(6.4)	67.7	(3.4)	65.7	(3.2)
Adequate (10.0-14.9 mg/mL)	13.6	(3.4)	13.7	(2.0)	14.6	(2.3)
Failure (Less than 10.0 mg/mL)	18.8	(5.0)	18.6	(2.5)	19.7	(2.5)
Total	100.0		100.0		100.0	

For calves fed by bottle or tube, about 7 of 10 tested had excellent passive transfer of immunity (68.2 percent and 72.4 percent, respectively). In comparison, about 5 of 10 calves (54.1 percent) that received their first feeding of colostrum by nursing their dams had excellent passive transfer of immunity.

h. Percentage of tested heifer calves by IgG passive transfer status, and by method of first feeding of colostrum

	Percent Calves							
	Colostrum Delivery Method							
	Hand-fed from Bottle		Hand-fed Using Esophageal Tube		Nursed Dam		Multiple Methods/Other	
IgG Passive Transfer Status	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Excellent (15.0 mg/mL or more)	68.2	(2.7)	72.4	(5.9)	54.1	(6.1)	64.1	(5.5)
Adequate (10.0-14.9 mg/mL)	16.0	(1.9)	6.3	(2.0)	17.8	(6.1)	10.7	(2.3)
Failure (Less than 10.0 mg/mL)	15.8	(1.8)	21.3	(6.1)	28.1	(5.0)	25.2	(4.6)
Total	100.0		100.0		100.0		100.0	

Calves allowed to nurse their dams were more likely to have failure of passive transfer than calves that did not —p value <0.05 (25.8 and 16.9 percent, respectively).

i. Percentage of tested heifer calves by IgG passive transfer status, and by whether calves nursed colostrum from their dams

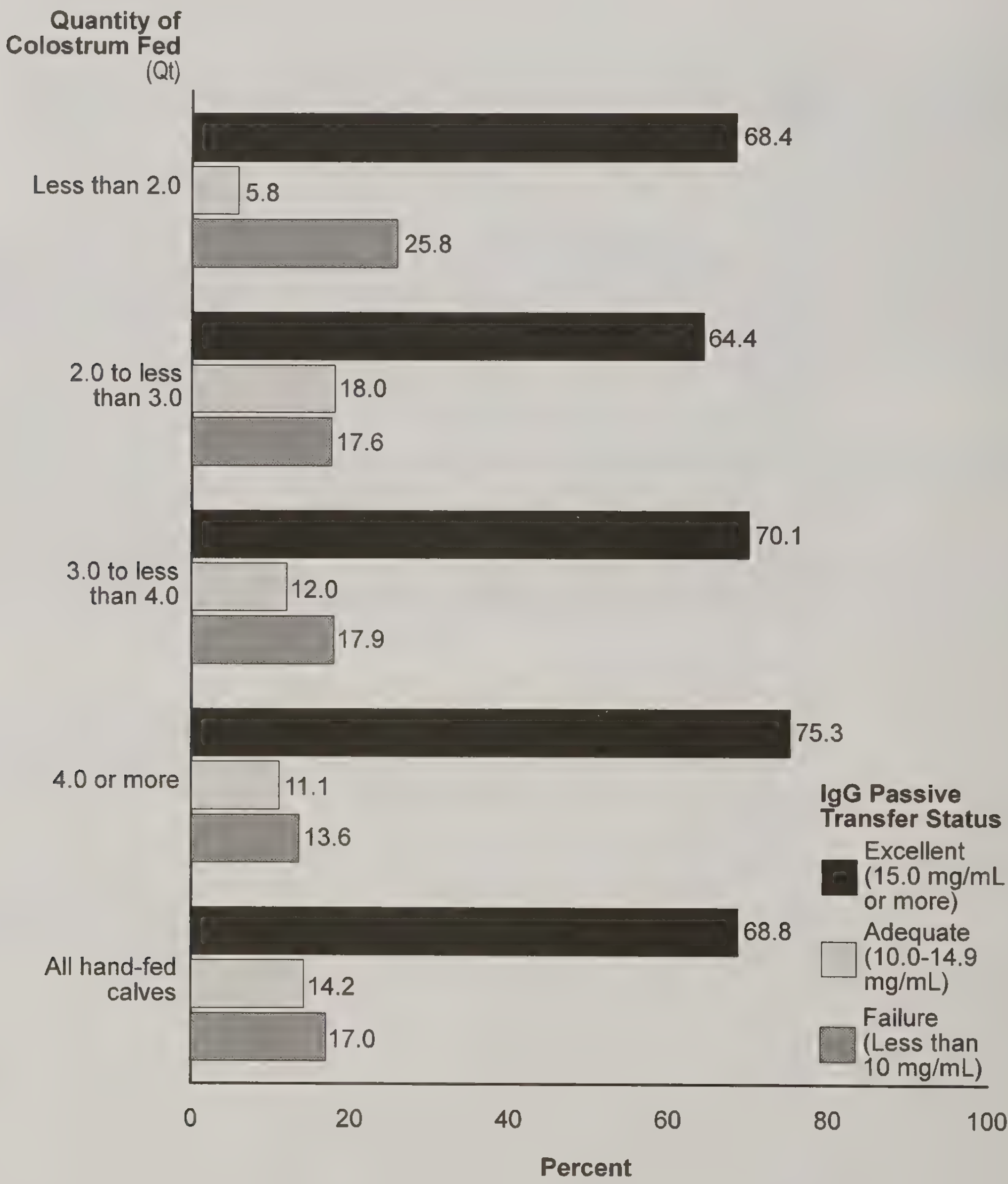
	Percent Calves			
	Nursed Dam			
	Yes		No	
IgG Passive Transfer Status	Percent	Std. Error	Percent	Std. Error
Excellent (15.0 mg/mL or more)	60.2	(4.2)	69.0	(2.5)
Adequate (10.0-14.9 mg/mL)	14.0	(3.0)	14.1	(1.6)
Failure (Less than 10.0 mg/mL)	25.8	(3.3)	16.9	(1.9)
Total	100.0		100.0	

For the 74.8 percent of calves not allowed to nurse their dams (table see table b., p62), failure of passive transfer occurred in 25.8 percent of calves that received less than 2.0 quarts of colostrum at first feeding and in 13.6 percent of calves that received 4.0 quarts or more. However, when considering the standard errors, these estimates were not substantially different.

j. For the 74.8 percent of calves not allowed to nurse their dams, percentage of tested heifer calves by IgG passive transfer status, and by quantity of colostrum administered at first feeding

	Percent Calves									
	Quantity of Colostrum Fed at First Feeding (Quarts)									
	Less than 2.0		2.0 to 2.9		3.0 to 3.9		4.0 or more		All Hand-fed Calves	
IgG Passive Transfer Status	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Excellent (15.0 mg/mL or more)	68.4	(8.2)	64.4	(3.7)	70.1	(6.5)	75.3	(3.8)	68.8	(2.5)
Adequate (10.0-14.9 mg/mL)	5.8	(3.2)	18.0	(2.6)	12.0	(3.0)	11.1	(2.6)	14.2	(1.6)
Failure (Less than 10.0 mg/mL)	25.8	(7.8)	17.6	(2.7)	17.9	(5.5)	13.6	(2.8)	17.0	(1.9)
Total	100.0		100.0		100.0		100.0		100.0	

For the 74.8 Percent of Calves not Allowed to Nurse their Dams, Percentage of Tested Heifer Calves by IgG Passive Transfer Status, and by Quantity of Colostrum Administered at First Feeding



5. Calf serum total protein passive transfer status

Serum samples collected from heifer calves for IgG testing were also tested for total protein. Serum total protein in calves is often used as an estimate of the serum IgG level. Previous studies have reported correlation between serum IgG levels and serum total protein for predicting passive transfer level and have suggested that a serum total protein greater than or equal to 5.0 to 5.2 g/dL correlates with an IgG level of 10 mg/mL or greater in healthy calves that are not dehydrated (Tyler et al., 1996).

In the following tables, passive transfer status was considered excellent if serum total protein level was 5.5 g/dL or greater. Passive transfer was considered adequate if total protein was 5.0 to 5.4 g/dL, and total protein less than 5.0 g/dL was defined as failure of passive transfer.

The percentages of tested calves by serum total protein passive transfer status were similar across herd sizes, between regions, and among seasons of birth. Over one-half of all calves had excellent passive transfer based on total protein levels (58.5 percent), and 21.3 percent had failure of passive transfer. As expected, these results are very similar to the IgG passive transfer results.

a. Percentage of tested heifer calves by serum total protein passive transfer status, and by herd size

	Percent Calves							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Serum Total Protein Passive Transfer Status	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Excellent (5.5 g/dL or more)	56.7	(3.6)	60.6	(2.8)	59.8	(6.1)	58.5	(2.3)
Adequate (5.0 to 5.4 g/dL)	20.8	(2.7)	20.3	(1.7)	18.4	(2.5)	20.2	(1.6)
Failure (Less than 5.0 g/dL)	22.5	(2.8)	19.1	(2.4)	21.8	(5.5)	21.3	(1.9)
Total	100.0		100.0		100.0		100.0	

b. Percentage of tested heifer calves by serum total protein passive transfer status, and by region

	Percent Calves			
	Region			
	West		East	
Serum Total Protein Passive Transfer Status	Percent	Std. Error	Percent	Std. Error
Excellent (5.5 g/dL or more)	63.5	(6.3)	57.5	(2.4)
Adequate (5.0 to 5.4 g/dL)	16.2	(2.6)	21.0	(1.8)
Failure (Less than 5.0 g/dL)	20.3	(5.6)	21.5	(2.0)
Total	100.0		100.0	

c. Percentage of tested heifer calves by serum total protein passive transfer status, and by season of birth

	Percent Calves					
	Season of Birth					
	Winter		Spring		Summer	
Serum Total Protein Passive Transfer Status	Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
Excellent (5.5 g/dL or more)	58.1	(7.9)	59.9	(3.5)	57.4	(3.2)
Adequate (5.0 to 5.4 g/dL)	20.8	(4.8)	21.7	(2.6)	19.0	(2.1)
Failure (Less than 5.0 g/dL)	21.1	(5.3)	18.4	(2.7)	23.6	(2.9)
Total	100.0		100.0		100.0	

About 8 of 10 calves fed by bottle had excellent or adequate passive transfer (81.4 percent). Excellent or adequate passive transfer status was seen in 73.7 percent of calves that received their first feeding of colostrum by nursing their dams and in 72.6 percent of calves that were fed by esophageal tube (see also IgG results in table h., p 65).

d. Percentage of tested heifer calves by serum total protein passive transfer status, and by method of first feeding of colostrum

	Percent Calves							
	Colostrum Delivery Method							
	Hand-fed from Bottle		Hand-fed Using Esophageal Tube		Nursed Dam		Multiple Methods/Other	
Serum Total Protein Passive Transfer Status	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Excellent (5.5 g/dL or more)	60.7	(2.9)	58.9	(6.0)	49.5	(5.0)	53.4	(5.9)
Adequate (5.0 to 5.4 g/dL)	20.7	(2.1)	13.7	(2.5)	24.2	(5.2)	21.3	(3.4)
Failure (Less than 5.0 g/dL)	18.6	(2.2)	27.4	(6.0)	26.3	(4.9)	25.3	(5.2)
Total	100.0		100.0		100.0		100.0	

The percentage of calves with failure of passive transfer based on serum total protein levels was similar between those that nursed and those that did not (25.2 and 20.0 percent, respectively) (see also IgG results in table i., p 66).

e. Percentage of tested heifer calves by serum total protein passive transfer status, and by whether calves nursed colostrum from their dams

	Percent Calves			
	Nursed Dam			
	Yes		No	
Serum Total Protein Passive Transfer Status	Percent	Std. Error	Percent	Std. Error
Excellent (5.5 g/dL or more)	51.8	(4.3)	60.7	(2.7)
Adequate (5.0 to 5.4 g/dL)	23.0	(3.1)	19.3	(1.8)
Failure (Less than 5.0 g/dL)	25.2	(3.7)	20.0	(2.1)
Total	100.0		100.0	

For the 74.8 percent of calves not allowed to nurse their dams (table b., p 62), failure of passive transfer based on serum total protein levels occurred in 25.3 percent of calves that received less than 2.0 quarts of colostrum and in 15.1 percent of calves that received 4.0 quarts or more (see also IgG results in table j., p67). However, as was the case with the IgG estimates, these estimates were not significantly different.

f. For the 74.8 percent of calves not allowed to nurse their dams, percentage of tested heifer calves by serum total protein passive transfer status, and by quantity of colostrum administered at first feeding

	Percent Calves									
	Quantity of Colostrum Fed at First Feeding (Quarts)									
	Less than 2.0		2.0 to 2.9		3.0 to 3.9		4.0 or more		All Hand-fed Calves	
Serum Total Protein Passive Transfer Status	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Excellent (5.5 g/dL or more)	64.8	(8.3)	55.6	(4.0)	60.9	(6.5)	67.3	(4.3)	60.6	(2.7)
Adequate (5.0 to 5.4 g/dL)	9.9	(4.7)	21.6	(2.6)	20.5	(4.8)	17.6	(3.1)	19.4	(1.8)
Failure (Less than 5.0 g/dL)	25.3	(7.1)	22.8	(3.4)	18.6	(5.4)	15.1	(3.2)	20.0	(2.1)
Total	100.0		100.0		100.0		100.0		100.0	

6. Comparison of IgG and total protein status

Total protein and IgG passive transfer status agreed in 75.4 percent of samples taken from heifer calves (excellent 55.1, adequate 6.4, and failure 13.9 percent). The highest percentage of results with disagreement occurred for calves with excellent passive transfer based on IgG, but only adequate passive transfer based on total protein (9.4 percent of calves).

Percentage of tested calves by IgG and serum total protein passive transfer status

	Percent Calves							
	IgG Passive Transfer Status							
	Excellent (15.0 mg/mL or more)		Adequate (10.0-14.9 mg/mL)		Failure (Less than 10.0 mg/mL)		Total	
Serum Total Protein Passive Transfer Status	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Excellent (5.5 g/dL or more)	55.1	(2.3)	2.5	(0.6)	0.9	(0.3)	58.5	(2.3)
Adequate (5.0-5.4 g/dL)	9.4	(1.1)	6.4	(0.9)	4.4	(0.8)	20.2	(1.6)
Failure (Less than 5.0 g/dL)	2.2	(0.5)	5.2	(1.0)	13.9	(1.5)	21.3	(1.9)
Total	66.7	(2.2)	14.1	(1.4)	19.2	(1.7)	100.0	

D. Nutrition

Note: Estimates in the following tables represent operations with any dairy cows.

1. Introduction

Calves undergo remarkable physiological changes from birth to weaning. At birth, the abomasum makes up almost 50 percent of the total weight of a calf's stomach (Warner and Flatt, 1965). The abomasum is often referred to as the true stomach because it digests proteins in a fashion similar to the stomach of a nonruminant (Davis and Drackley, 1998). During the first few weeks of life, calves receive most of their energy by digesting milk or milk replacer in the abomasum and the small intestine. Young calves have a unique feature called the esophageal groove that helps deliver milk directly to the abomasum. The esophageal groove is a tube created by the contraction of certain muscles in the esophagus. These muscles lie in a fold of tissue that extends from the base of the esophagus (cardia) to the reticulo-omasal orifice (Orskov et al., 1970; Orskov, 1972). Because of the esophageal groove, 97 percent of the milk or milk replacer bypasses the reticulorumen and enters the abomasum, where it can be digested to provide nutrients for the calf (Tuolloc and Guilloteau, 1989).

2. Liquid diets (milk/milk replacer)

Selecting a suitable liquid feeding plan is important to the health of dairy calves. Producers must select an appropriate liquid diet that will support the calves until they are weaned. Liquid diets commonly fed to dairy calves include commercial milk replacer, saleable milk, and nonsaleable milk.

Until the 1950s, most dairy calves were fed whole milk (Otterby and Linn,1981). Although pasteurized saleable milk is an excellent source of nutrition for calves, it has traditionally been the most expensive liquid diet option (Davis and Drackley, 1998). Commercial milk replacers were developed in the 1950s as an economical alternative to feeding saleable milk. Other advantages of milk replacers include easy storage, diet consistency from day to day, and disease control (Davis and Drackley, 1998). The table below shows a comparison between whole milk and a 20:20 (percent fat: percent protein) milk replacer. Whole milk has higher amounts of protein and fat per gallon compared with most milk replacers. Despite this, if calves are fed large amounts of high quality milk replacer their growth can equal that of calves fed whole milk. When comparing milk replacer to whole milk, it is important to compare them based on equal calf nutrient intake. In other words, since milk contains more energy per gallon, feeding 2 quarts of milk replacer is not equal to feeding 2 quarts of whole milk.

a. Comparison of whole milk and milk replacer

Parameter	Whole Milk	20:20 Milk Replacer (1 lb/gal water)
Total solids (percent)	12.5	11.4
Fat* (percent)	28.8	20.7
Protein* (percent)	27.1	20.7
lb protein/gal	0.285	0.190
lb fat/gal	0.317	0.190

*Dry matter basis: since milk replacer is about 96 to 98 percent dry matter, a product that contains 20 percent fat on the label actually contains 20.7 percent fat on a dry matter basis. Source: adapted from Corbett (2007) and Jones et al. (2007).

Many commercial milk replacers are available, most of which contain 18 to 28 percent protein and 10 to 22 percent fat. A number of different protein sources are used in milk replacers. Milk-derived proteins such as dried skim milk, casein, and dried whey are most common; soy protein, egg, and animal plasma are also used. The most common source of fat is tallow or lard. Other important ingredients include carbohydrates, trace minerals, and vitamins A, B, D, and E. Some milk replacers are medicated with lasalocid or decoquinate (anticoccidials) or contain subtherapeutic levels of antibiotics intended to prevent calf scours. The use of subtherapeutic antibiotics is coming under scrutiny due to concerns about antimicrobial resistance. A recent study showed that calves fed a medicated milk replacer had decreased overall morbidity and increased weight gain compared with calves fed a nonmedicated milk replacer. However, the most important factor in reducing calf morbidity and mortality was successful passive transfer provided through colostrum. The study concluded that removal of antibiotics from milk replacers may have a significant negative impact on calf health in the absence of adequate passive transfer (Berge et al., 2005).

Nonsaleable milk is another liquid-diet option for calves. Nonsaleable milk typically includes surplus colostrum, transition milk, abnormal (mastitic) milk, and milk from cows treated with medications that call for a withdrawal period. Disease transmission via pathogens in milk is one concern about feeding raw, nonsaleable milk to calves; Selim and Cullor (1997) showed that unpasteurized, nonsaleable milk had more bacteria than milk replacer or saleable (bulk-tank) milk. To reduce bacterial contamination, nonsaleable milk can be pasteurized. Pasteurization destroys or significantly decreases the number of pathogens that can affect calf health, without affecting milk quality (Stabel et al., 2004). However, pasteurization is a labor-intensive process that requires frequent monitoring of equipment and the feeding system.

Feeding pasteurized nonsaleable milk to calves may offer economic advantages over feeding saleable milk or milk replacers. A study by Godden et al. (2005) showed that calves fed pasteurized nonsaleable milk gained more weight, had higher weights at weaning, lower morbidity in summer, and lower morbidity and mortality in winter than calves fed an equal volume of milk replacer. However, these findings were expected since calves fed pasteurized nonsaleable milk received more dry matter protein and energy than those fed milk replacer. In addition, feeding waste milk resulted in a savings of $0.69 per calf per day when compared with feeding milk replacer.

Despite the possible economical advantages to feeding pasteurized nonsaleable milk, some concern exists about antibiotic residues and the lack of consistency of the diet from day to day. In a study in which calves were fed surplus colostrum, diet variability from day to day did not impact weight gain or increase the occurrence of scours (Foley and Otterby, 1978); however, most operations fed a blend of colostrum, transition milk, waste milk, and milk replacer. More studies are needed to investigate the effects of antibiotic residues in nonsaleable milk. In one trial, Wray et al. (1990) found an increase in streptomycin resistance of intestinal bacteria in calves fed waste milk containing antibiotics; however, no increase in antibiotic resistance was observed when the trail was repeated. Langford et al. (2003) reported an increase in resistance of intestinal bacteria when milk was artificially spiked with varying amounts of penicillin (6.25, 12.5, 25 and 50 microliters of 10,000 IU/mL Penicillin G per kilogram of milk).

Regardless of the type of liquid diet fed, adequate nutrition must be provided to prevent disease and promote growth. The 2001 Nutrient Requirements of Dairy Cattle (National Research Council, Nutrient Requirements of the Young Calf, chapter 10 and the computer calf model) can be used as a guide for determining a specific feeding plan for milk or milk replacer. Daily feeding quantities should be based on the weather conditions, the health of the calf, the calf's weight, and the desired growth rate for the calf. It is important to note that feeding strategies must be adjusted when the temperature is outside the thermoneutral range (60 to 68 °F). At higher or lower temperatures, more whole milk or milk replacer must be fed. Otherwise, calves will use energy reserves to maintain body temperature, instead of using the energy for growth and the maintenance of a healthy immune system. For example, at 25 °F, calves require 32 percent more energy than they do when the temperature is in the thermoneutral zone (Scibilia et al., 1987). Management practices recommended for cold weather (less than 60 °F) include: milk/milk replacer and water should be warmed to about 105 °F prior to feeding; and the amount of nutrition provided should be increased by either increasing the solids content of the milk replacer to 15 to 18 percent, adding additional fat to the diet, or feeding a third meal consisting of 25 to 50 percent more milk or milk replacer (BAMN, 2003; Corbett, 2007).

To summarize, selecting a liquid feeding program on a particular operation depends upon performance goals for calves, the number of calves, economics, disease concerns, individual

preferences, and the availability of resources (i.e., supply of nonsaleable milk). Appropriate management decisions in this area can improve calf health and growth efficiency.

A higher percentage of large operations (26.4 percent) fed nonmedicated milk replacer than medium and small operations (14.2 and 11.4 percent, respectively). Alternatively, small and medium operations (55.2 and 68.2 percent, respectively) were more likely to feed medicated milk replacer than large operations (43.6 percent). Overall, medicated milk replacer (including antibiotics and anticoccidials) was fed on more than one-half of all operations (57.5 percent). A higher percentage of large operations (28.7 percent) fed pasteurized waste milk compared with medium and small operations (3.0 and 1.0 percent, respectively). Small operations (32.2 percent) were more likely to feed unpasteurized whole (saleable) milk than medium and large operations (17.4 and 12.1 percent, respectively). Similar percentages of operations fed unpasteurized waste milk and unpasteurized whole (saleable) milk (30.6 and 28.0 percent, respectively).

b. Percentage of operations by type of liquid diet fed to heifers calves at any time prior to weaning during 2006, and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Liquid Diet	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Nonmedicated milk replacer	11.4	(1.2)	14.2	(1.7)	26.4	(2.4)	12.7	(0.9)
Medicated milk replacer	55.2	(1.8)	68.2	(2.1)	43.6	(3.1)	57.5	(1.4)
Unpasteurized waste milk	32.2	(1.7)	25.7	(2.0)	27.6	(2.8)	30.6	(1.3)
Pasteurized waste milk	1.0	(0.3)	3.0	(0.9)	28.7	(2.7)	2.8	(0.3)
Unpasteurized whole (saleable) milk	32.2	(1.7)	17.4	(1.7)	12.1	(1.9)	28.0	(1.3)
Pasteurized whole (saleable) milk	1.3	(0.4)	1.6	(0.8)	2.0	(0.7)	1.4	(0.3)
Other	2.6	(0.6)	3.5	(0.9)	4.9	(1.8)	2.9	(0.5)

The percentages of heifers by type of liquid diets fed were similar to the percentages of operations by type of liquid diets fed. About one-half of all heifers (49.9 percent) received medicated milk replacer at some point prior to weaning. Although only 2.8 percent of operations fed pasteurized waste milk, 15.0 percent of heifers received pasteurized waste milk, suggesting that this practice was more common on larger operations.

c. Percentage of heifers by type of liquid diet fed any time prior to weaning during 2006, and by herd size

	Percent Heifers							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Liquid Diet	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Nonmedicated milk replacer	10.4	(1.1)	13.7	(1.7)	27.9	(2.6)	19.1	(1.3)
Medicated milk replacer	57.9	(1.8)	63.0	(2.2)	36.4	(3.0)	49.9	(1.5)
Unpasteurized waste milk	23.2	(1.5)	20.3	(1.8)	19.9	(2.5)	20.9	(1.3)
Pasteurized waste milk	1.2	(0.3)	2.6	(0.6)	31.5	(2.6)	15.0	(1.2)
Unpasteurized whole (saleable) milk	25.5	(1.6)	13.3	(1.5)	6.9	(1.3)	13.8	(0.8)
Pasteurized whole (saleable) milk	0.9	(0.3)	0.6	(0.3)	1.4	(0.6)	1.0	(0.3)
Other	1.6	(0.4)	3.1	(0.9)	3.7	(1.3)	3.0	(0.6)

The most common medications in milk replacer at the operation level were oxytetracycline in combination with neomycin (49.5 percent of operations). Oxytetracycline and decoquinate were fed on nearly one of five operations (21.9 and 18.8 percent, respectively).

d. For operations that fed a medicated milk replacer to heifers during 2006, percentage of operations by type of medication used

Medication	Percent Operations	Standard Error
Chlortetracycline (CTC)	12.1	(1.1)
Oxytetracycline (OTC)	21.9	(1.5)
Oxytetracycline in combination with Neomycin (Oxy NEO)	49.5	(1.9)
Decoquinate	18.8	(1.4)
Lasalocid	7.2	(0.9)
Other	5.4	(0.9)

Calf-feeding equipment should be cleaned between calves to prevent the spread of disease from one calf to another. Approximately one of four operations (24.4 percent) cleaned calf-feeding equipment between calves. A higher percentage of large and medium operations (39.1 and 30.9 percent, respectively) cleaned equipment between calves compared with small operations (21.4 percent). The majority of operations (58.5 percent) cleaned equipment daily, and there was no difference by herd size in the percentage of operations that cleaned daily. Small and medium operations were more likely to clean equipment weekly (7.0 and 5.2 percent, respectively) than large operations (1.3 percent). "Other" frequency accounted for 7.5 percent of operations, and a high percentage of these operations cleaned equipment twice daily, but not between calves.

e. Percentage of operations by frequency milk feeding equipment* was cleaned and disinfected, and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Frequency	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Between calves	21.4	(1.5)	30.9	(2.2)	39.1	(2.7)	24.4	(1.2)
Daily	59.8	(1.8)	55.9	(2.3)	51.8	(2.8)	58.5	(1.4)
Weekly	7.0	(1.0)	5.2	(0.9)	1.3	(0.9)	6.4	(0.8)
Monthly	3.8	(0.7)	1.4	(0.6)	2.2	(1.0)	3.2	(0.5)
Other	8.0	(1.0)	6.6	(1.1)	5.6	(1.3)	7.5	(0.8)
Total	100.0		100.0		100.0		100.0	

*Bottles, buckets, nipples.

3. Water and calf starter

Calves should be offered free-choice water from birth for several reasons. A study showed that calves not offered water consume milk to satisfy their thirst. In this situation, the esophageal groove did not close, and milk was delivered to the forestomach (Orskov, 1972). In addition, research has shown that calves given free-choice water from birth to 4 weeks of age ate more dry feed, had improved daily weight gain, and had no increase in incidence of scours compared with calves deprived of water (Kertz et al., 1984). Detailed recommendations for providing water, starter, and hay to calves can be found in "A Guide to Dairy Calf Feeding and Management" (BAMN, 2003).

Rumen maturation in calves is triggered by the introduction of calf starter. Specifically, the microbial fermentation of carbohydrates and proteins in the dry feed produces volatile fatty acids (VFAs): acetic, propionic, and butyric acids. Butyric and propionic acids are the principal VFAs involved in accelerating forestomach (rumen, reticulum, and omasum) development; they directly affect proliferation and differentiation of gastrointestinal epithelial cells, and they provide energy for the growing stomach tissue (McGilliard et al., 1965; Velazquez et al., 1996). Thus, to ensure normal rumen development and achieve the economic benefits of an early weaning age for calves, high quality calf starter should be introduced by the time calves are 4 days old.

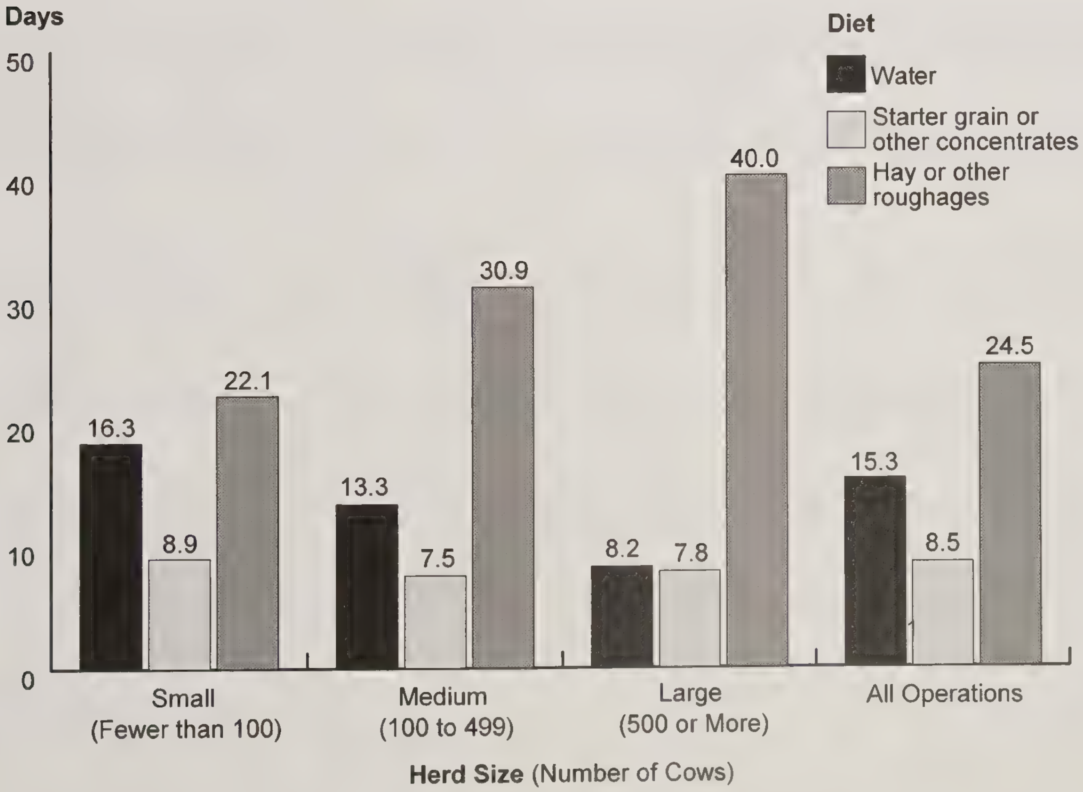
Producers should begin by offering small amounts of calf starter, replacing it daily. Hay should not be fed to calves prior to weaning because—compared with calves fed a high quality, properly balanced starter—it may delay rumen development. Calves fed primarily grain (starter) have better development of rumen tissue, longer papillae, and heavier rumen weight than calves fed primarily hay (Stobo et al. [1966]; Davis and Drackley [1998]). The best time to start hay is after weaning, when calves are about 8 to 10 weeks old and consistently consuming a minimum of 5 pounds of starter daily.

Across all operations, water was offered to calves at 15.3 days of age on average. Large operations offered water earlier (8.2 days) than medium and small operations (13.3 and 16.3 days, respectively). Starter was routinely offered at an average of 8.5 days of age. The average age of heifers receiving hay or other roughage increased as operation size increased, ranging from 22.1 days of age on small operations to 40.0 days on large operations.

Operation average age (days) of preweaned heifers when heifers were routinely offered the following diets, by herd size

	Operation Average Age (Days)							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Diet	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error
Water	16.3	(0.7)	13.3	(0.8)	8.2	(0.9)	15.3	(0.6)
Starter grain or other concentrate	8.9	(0.3)	7.5	(0.4)	7.8	(0.7)	8.5	(0.3)
Hay or other roughage	22.1	(0.7)	30.9	(1.1)	40.0	(1.9)	24.5	(0.6)

Operation Average Age (Days) of Preweaned Heifers When Heifers were Routinely Offered the Following Diets, by Herd Size



E. Growth from Birth to Weaning

Estimates in the following tables represent only operations with 30 or more dairy cows.

1. Introduction

Dairy heifer growth represents the culmination of many feeding, health, and management practices. Growth is fundamentally important in determining the age at which heifers can be bred and become productive. Heifers that calve with less than optimal body weight produce less milk during first lactation and are, therefore, less profitable to the dairy producer.

Heifer growth was measured as part of the Dairy 2007 study. Measurements of heart girth and wither height were taken from heifers between birth and weaning using a Coburn calf tape. Calf weight was estimated based on the girth measurement. Each heifer was measured only once, and her age was recorded at the time of measurement.

A total of 5,381 heifer calves from 418 operations were evaluated for growth parameters, of which 4,667 were Holsteins (386 operations). The remaining calves were comprised of Jersey, Brown Swiss, Guernsey, and crossbreed dairy cattle whose numbers were too small to report growth curves.

The following tables allow producers to compare their Holstein heifers with other heifers in the United States. A recommended goal for producers is to have their heifers fall somewhere near the 75th percentile. For more information, and for instructions on measuring heifers, producers can refer to the Penn State publication “Monitoring Dairy Heifer Growth” (Heinrichs and Lammers, 1998).

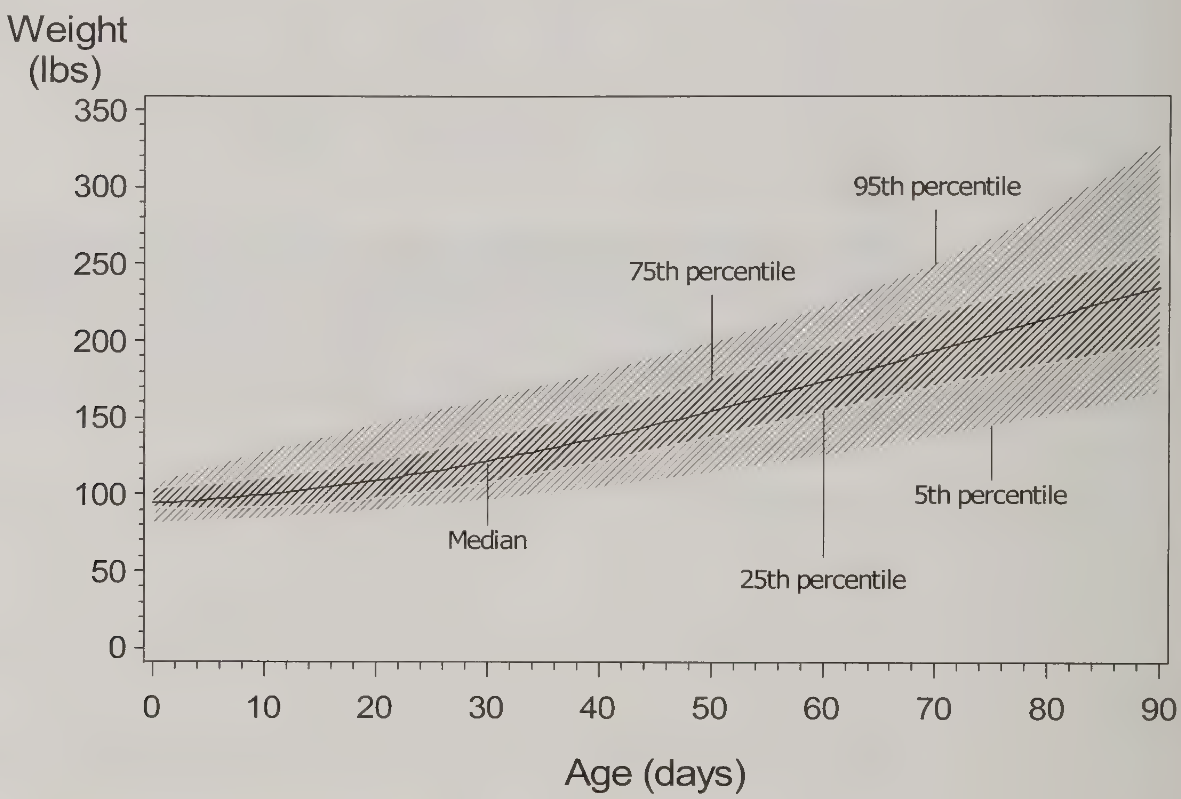
2. Holstein growth parameters

At one month of age (28 to 34 days), the median weight of a Holstein heifer calf was 126 pounds; at 2 months of age (56 to 62 days) the median weight was 177 pounds; and by 3 months of age (84 to 90 days) the median was 236 pounds. For comparison, data collected during the NAHMS' NDHEP study conducted in 1991-92 indicated that the median weights for Holstein heifer calves at 1, 2, and 3 months of age were 119, 161, and 211 pounds, respectively (Heinrichs and Lammers, 1998).

a. Percentile and weight (pounds) of Holstein heifers, by age (days)

	Weight (Pounds)		
Age (Days)	**25th Percentile**	**Median**	**75th Percentile**
Less than 7	91	97	105
7 to 13	91	101	115
14 to 20	97	105	115
21 to 27	97	115	126
28 to 34	115	126	138
35 to 41	120	138	151
42 to 48	126	151	164
49 to 55	138	151	177
56 to 62	157	177	204
63 to 69	171	191	220
70 to 76	171	191	212
77 to 83	184	204	236
84 to 90	204	236	260

Percentile and Weight (pounds) of Holstein Heifers, by Age (Days)

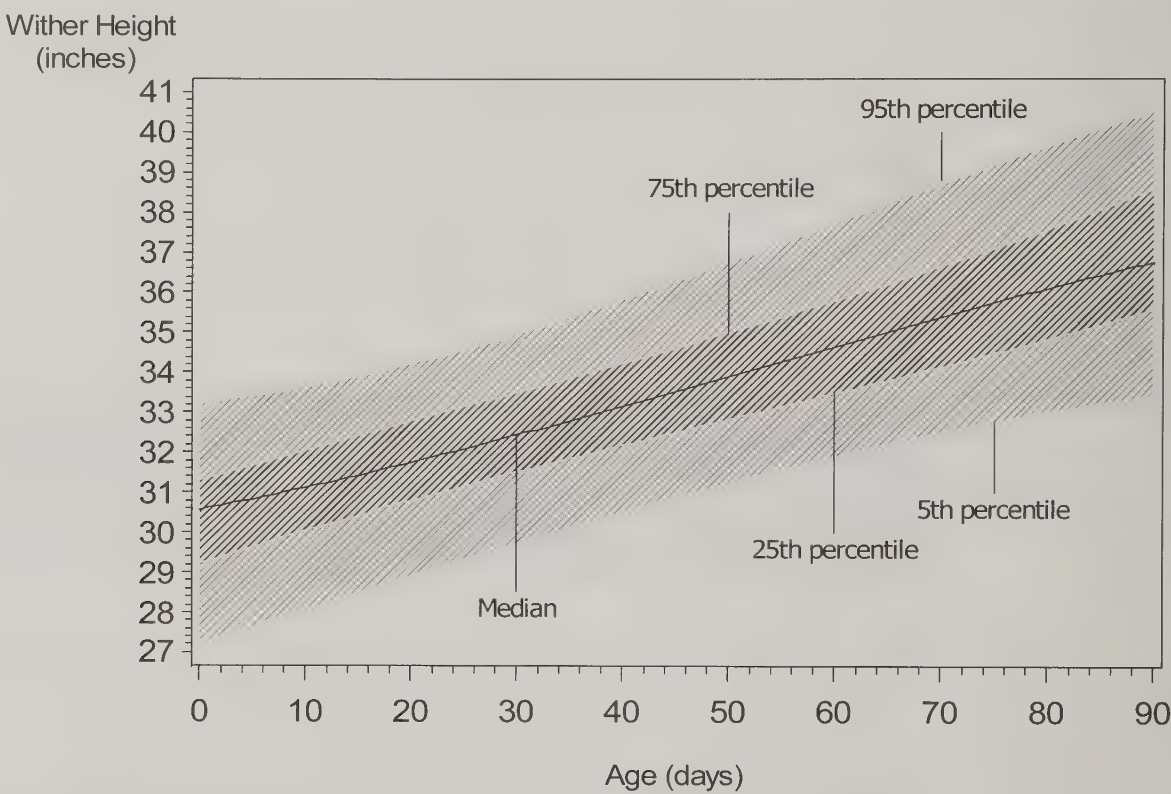


The median wither height for Holstein heifer calves was 32.5 inches at 1 month of age (28 to 34 days), 35.0 inches at 2 months (56 to 62 days), and 37.0 inches at 3 months (84 to 90 days). For comparison, data collected during the NAHMS' NDHEP study conducted in 1991-92 indicated that the median wither heights for Holstein heifer calves at 1, 2, and 3 months of age were 31.0, 33.0, and 35.0 inches, respectively (Heinrichs and Lammers, 1998).

b. Percentile and wither height (inches) of Holstein heifers, by age (days)

	Wither Height (Inches)		
Age (Days)	**25th Percentile**	**Median**	**75th Percentile**
Less than 7	30.0	31.0	32.0
7 to 13	30.0	31.0	32.3
14 to 20	30.5	31.5	33.0
21 to 27	31.0	32.0	33.0
28 to 34	31.5	32.5	33.0
35 to 41	32.0	34.0	35.0
42 to 48	32.5	34.0	35.0
49 to 55	33.0	34.0	35.0
56 to 62	34.0	35.0	36.5
63 to 69	34.0	35.0	37.0
70 to 76	34.0	35.0	36.0
77 to 83	35.0	36.0	37.0
84 to 90	35.0	37.0	38.0

Percentile and Wither Height (Inches) of Holstein Heifers, by Age (Days)



F. General Management

Note: Unless otherwise specified, estimates in the following tables represent operations with any dairy cows.

1. Housing

Housing design plays an important role in maximizing calf health, especially with the diverse climates across the United States. Housing for preweaned calves should provide a dry area with shelter that does not allow contact with other calves or, especially, older animals. Providing a deep layer of dry bedding is important to keep the calves warm during cold weather. For preweaned calves, hutches or individual animal pens are usually recommended. Individual hutches have several advantages. Hutches keep calves separated, thereby reducing the spread of disease, and they offer calves a choice of several different thermal zones: the back of the hutch, the front of the hutch, and the outdoor pen (Brunswold et al., 1985). The primary disadvantage of hutches is the difficulty that dairy personnel face in caring for calves during a snowstorm or other adverse weather event, particularly on operations with a large number of calves. Some operations house preweaned calves in individual pens inside a barn. This design is easier on caretakers and can be an effective system as long as the barn is adequately ventilated. After weaning, heifers are usually placed in group housing with other animals of similar age.

The majority of operations (74.9 percent) housed preweaned heifers in individual animal pens or hutches at some point during 2006. Approximately one-half of operations housed weaned heifers on pasture and/or in inside and outside multiple-animal areas (49.2, 55.6, and 44.6 percent of operations, respectively).

a. Percentage of operations by type of housing used for any length of time during 2006, and by cattle class

	Percent Operations			
	Cattle Class			
	Preweaned Heifers		Weaned Heifers	
Housing Type	Percent	Std. Error	Percent	Std. Error
Tie stall/ stanchion	12.1	(1.0)	12.2	(1.0)
Freestall	5.6	(0.7)	20.9	(1.2)
Individual pen/hutch	74.9	(1.3)	15.6	(1.1)
Drylot/multiple-animal outside area	5.2	(0.7)	44.6	(1.4)
Multiple-animal inside area	23.6	(1.3)	55.6	(1.5)
Pasture	6.3	(0.7)	49.2	(1.5)
Other	1.5	(0.3)	1.8	(0.4)

The most common primary housing types were individual-animal pens/hutches for preweaned heifers and multiple-animal inside areas for weaned heifers.

b. Percentage of operations by primary housing facility/outside area used during 2006, and by cattle class

	Percent Operations			
	Cattle Class			
	Preweaned Heifers		Weaned Heifers	
Housing Type	Percent	Std. Error	Percent	Std. Error
Tie stall/stanchion	8.9	(0.8)	5.9	(0.7)
Freestall	2.7	(0.5)	12.1	(0.9)
Individual pen/hutch	67.9	(1.3)	5.3	(0.7)
Drylot/multiple-animal outside area	0.6	(0.2)	22.9	(1.1)
Multiple-animal inside area	14.2	(1.1)	34.6	(1.4)
Pasture	0.6	(0.2)	10.8	(0.9)
Not housed on operation	4.7	(0.5)	7.7	(0.7)
Other	0.4	(0.2)	0.7	(0.2)
Total	100.0		100.0	

2. Off-site heifer raising

Heifer rearing represents about 20 percent of the total operating expenses on dairy operations, making it the second largest expense behind feeding costs (Heinrichs, 1993). To raise heifers, dairies invest money and resources in feed, labor, and housing without receiving a return on their investments until the heifers calve, usually around 24 months of age. As dairy operations become larger (increased number of cows), the use of off-site calf ranches is increasingly common (Wolf, 2003). Calf ranches that raise a large number of heifers likely realize economies of scale that may allow them to produce heifers at a cost lower than an individual dairy farm.

Calves are transported to calf ranches at a predetermined age, such as prior to or after weaning. Typically, producers and calf ranches enter into a contract that specifies expectations of care, growing performance, and payment responsibilities. Various types of contracts are used, such as contracts in which producers pay calf ranches by the day or by pound of gain, or contracts in which producers sell heifers to the ranch upon delivery and retain the option to buy them back prior to freshening.

On operations with limited facilities, labor, or other components of a dairy operation, contracting with an off-site calf ranch has many advantages. Calf-ranch personnel are usually dedicated to working only with calves, which can result in increased attention to the feeding and health of calves and also decreased exposure to adult-cow diseases. In addition, if calves are not commingled with older animals or animals from other operations, their exposure to disease agents such as *Mycobacterium avium* subspecies *paratuberculosis* (the causative agent of Johne's disease) is reduced. Moving heifers off-site frees-up labor and space previously dedicated to heifer housing and feed-storage facilities. This extra labor and space can be used for the milking herd. Raising heifers off-site also reduces the amount of manure produced at single sites and/or may allow producers to maintain larger milking herds on the same acreage. Using off-site calf ranches may enable producers to reduce expenses, especially if the heifer-raising aspect of the operation is costly or inefficient, which might be indicated by consistent, higher-than-normal calf illness or death loss, or by heifers that calve later than 24 months of age and/or calve at suboptimal weights.

There can be drawbacks to using off-site calf ranches. For example, many calf ranches commingle heifers from different operations, presenting an increased risk of disease introduction. Wolf (2003) found that only 6 of 57 calf ranches permanently separated heifers according to farm of origin during the rearing period. Other drawbacks of using calf ranches include less control over management practices used in raising heifers, transportation costs of moving heifers to the off-site facility, and issues related to entering into and meeting contract obligations.

In Dairy 2007, about 1 of 10 operations (9.3 percent) raised some dairy heifers off the operation. The percentages of operations that raised heifers off-site increased as herd size increased for all heifer classes. Less than 5 percent of small operations raised any heifers off-site, compared with 15.5 percent of medium operations and 46.0 percent of large operations. Almost one-third of large operations (35.3 percent) raised preweaned calves off-site, compared with 7.1 percent of medium operations and 1.7 percent of small operations. Similar herd-size differences in the percentages of operations that raised heifers off-site were observed among all three heifer classes.

a. Percentage of operations that had any heifers raised off-site, by heifer class and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Heifer Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Preweaned	1.7	(0.5)	7.1	(1.2)	35.3	(2.9)	4.6	(0.5)
Weaned	4.3	(0.7)	14.6	(1.6)	44.2	(2.9)	8.6	(0.7)
Bred	4.1	(0.7)	11.5	(1.5)	22.5	(2.3)	6.7	(0.6)
Any of the above	4.7	(0.7)	15.5	(1.7)	46.0	(2.9)	9.3	(0.7)

For operations that raised any heifers off the operation, preweaned, weaned, and bred heifers were sent off-site at an operation average age of 4.9, 189.8, and 413.8 days, respectively. The average age at which any calves left to be raised off-site was 110.3 days.

b. For the 9.3 percent of operations that had any heifers raised off-site, operation average age of heifers when leaving operation, by heifer class

Operation Average Age (Days)							
Heifer Class							
Preweaned		Weaned		Bred		All Operations	
Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error
4.9	(0.7)	189.8	(15.7)	413.8	(25.3)	110.3	(11.2)

Producers were asked to identify the primary class of heifers sent off-site. Almost one-half of operations that sent any heifers off-site to be raised sent preweaned or weaned calves (50.1 and 44.1 percent of operations, respectively). Only 5.8 percent of operations sent bred heifers off-site to be raised. Medium operations sent similar percentages of preweaned and weaned calves off-site (45.6 and 49.7 percent, respectively), and large operations most frequently sent preweaned heifers off-site (77.2 percent).

c. For the 9.3 percent of operations that had any heifers raised off-site, percentage of operations by primary heifer class raised off-site and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Heifer Class	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Preweaned	35.9	(7.7)	45.6	(5.8)	77.2	(3.3)	50.1	(3.8)
Weaned	54.3	(7.9)	49.7	(5.9)	21.1	(3.2)	44.1	(3.8)
Bred	9.8	(4.0)	4.7	(2.4)	1.7	(0.6)	5.8	(1.7)
Total	100.0		100.0		100.0		100.0	

About 8 of 10 operations that sent heifers off-site to be raised (81.1 percent) retained ownership of the heifers sent. A total of 9.4 percent of operations sold the heifers sent off-site and repurchased the same animals, and 9.5 percent of operations sold the animals sent and replaced them with different animals.

d. For the 9.3 percent of operations that had any heifers raised off-site, percentage of operations by ownership of the majority of heifers and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Ownership	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Ownership retained	72.3	(7.5)	83.8	(4.1)	89.6	(2.1)	81.1	(3.3)
Same animals sold and then repurchased	11.1	(6.1)	10.0	(3.2)	6.0	(1.6)	9.4	(2.6)
Animals sold outright, replaced with different animals	16.6	(5.6)	6.2	(2.8)	4.4	(1.4)	9.5	(2.4)
Total	100.0		100.0		100.0		100.0	

For operations that sent heifers off-site to be raised, the highest percentage of small and medium operations transported heifers fewer than 20 miles to the rearing facility, while the highest percentage of large operations transported heifers between 5 and 50 miles. A total of 10.6 percent of operations transported heifers 50 miles or more.

e. For the 9.3 percent of operations that had any heifers raised off-site, percentage of operations by number of miles heifers were transported to the off-site rearing facility, and by herd size

Percent Operations

Herd Size (Number of Cows)

	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Miles	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Fewer than 5.0	43.5	(8.4)	26.0	(5.4)	10.1	(2.8)	27.6	(3.7)
5.0 to 19.9	35.3	(8.7)	47.5	(6.1)	37.7	(4.4)	40.8	(3.9)
20.0 to 49.9	12.8	(5.2)	18.8	(4.7)	34.5	(4.7)	21.0	(3.0)
50 or more	8.4	(4.3)	7.7	(2.7)	17.7	(2.7)	10.6	(2.0)
Total	100.0		100.0		100.0		100.0	

Relatively few operations (4.1 percent) transported heifers out of State for rearing.

f. For the 9.3 percent of operations that had any heifers raised off-site, percentage of operations in which heifers were ever transported out of State for off-site rearing, by herd size

Percent Operations

Herd Size (Number of Cows)

Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
1.9	(1.8)	2.6	(1.5)	9.1	(1.8)	4.1	(1.0)

Producers were asked to choose the description that best described their primary off-site rearing facility. Ideally, heifer-raising facilities would only house animals from one operation. More than one-fourth of operations (27.7 percent) sent heifers to a single rearing facility in which heifers did not have contact with cattle from other operations, but the majority (51.3 percent) sent heifers to a single rearing facility in which heifers had contact with cattle from other operations.

g. For the 9.3 percent of operations that had any heifers raised off-site, percentage of operations by primary off-site rearing facility

Off-site Rearing Facility	Percent Operations	Standard Error
Heifers sent to a single rearing facility and did not have contact with cattle from other operations	27.7	(3.3)
Heifers sent to multiple rearing facilities and did not have contact with cattle from other operations	8.5	(2.1)
Heifers sent to a single rearing facility and had contact (commingled) with cattle from other operations	51.3	(4.0)
Heifers sent to multiple rearing facilities and had contact (commingled) with cattle from other operations	12.5	(3.0)
Total	100.0	

On average, weaned and bred heifers returned to the operation from the rearing facility at 7.0 and 21.6 months of age, respectively. The operation average age of any heifers returning was 17.3 months.

h. For the 9.3 percent of operations that had any heifers raised off-site, operation average age that heifers returned to the operation, by heifer class

Operation Average Age (Months)							
Heifer Class[1]							
Weaned		Bred		Other[2]		All Operations	
Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error
7.0	(0.6)	21.6	(0.3)	28.6	(1.0)	17.3	(0.6)

[1]No operations reported preweaned heifers returning from an off-site rearing facility.
[2]Heifers that had calved.

Producers were asked to identify the primary class of heifer replacements usually arriving or returning to the operation. About two of three operations that sent any heifers off-site (67.6 percent) brought bred heifers back to the operation from the rearing facility. About one of three operations (30.3 percent) brought back weaned heifers, while just 2.1 percent brought back "other" heifers (primarily heifers that had calved). A higher percentage of large operations (53.4 percent) brought back weaned heifers compared with medium and small operations (27.3 and 15.1, respectively). A higher percentage of small and medium operations (79.1 and 72.2 percent, respectively) brought back bred heifers compared with large operations (46.6 percent).

i. For the 9.3 percent of operations that had any heifers raised off-site, percentage of operations by primary class of heifers arriving or returning to the operation, and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Heifer Class[1]	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Weaned	15.1	(6.0)	27.3	(5.1)	53.4	(4.7)	30.3	(3.4)
Bred	79.1	(6.7)	72.2	(5.2)	46.6	(4.7)	67.6	(3.5)
Other[2]	5.8	(3.4)	0.5	(0.5)	0.0	(0.0)	2.1	(1.2)
Total	100.0		100.0		100.0		100.0	

[1]No operations reported preweaned heifers returning from an off-site rearing facility.
[2]Heifers that had calved.

3. Weaning age

Weaning is a stressful time for calves. To reduce this stress, calves should only be weaned when they are healthy and should not be moved to different housing for 1 week after weaning. Deciding when to wean calves should be based on starter intake rather than age. When a calf has eaten 2 pounds of calf starter per day for three consecutive days, it is ready to be weaned (Corbett, 2007).

If careful attention is paid to proper nutrition, calves can often be weaned at a relatively young age (5 to 7 weeks). Early weaning can cut costs because feeding calf starter is less expensive and less labor-intensive than feeding milk or milk replacer.

The operation average age at weaning was 8.2 weeks, with large operations weaning calves at an older age (9.1 weeks) than medium and small operations (7.9 and 8.2 weeks, respectively).

a. Operation average age of heifers at weaning, by herd size

Operation Average Age (Weeks)							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error	Avg.	Std. Error
8.2	(0.1)	7.9	(0.1)	9.1	(0.2)	8.2	(0.1)

About one-third of operations (33.2 percent) weaned heifers at 8 weeks of age, while 20.5 percent weaned heifers at 6 weeks. Less than 5 percent of operations (4.8 percent) weaned heifers at 4 weeks of age.

b. Percentage of operations by average weaning age of heifers

Operation Average Weaning Age (Weeks)	Percent Operations	Standard Error
4	4.8	(0.6)
5	5.6	(0.6)
6	20.5	(1.2)
7	10.3	(0.8)
8	33.2	(1.4)
9	4.5	(0.6)
10	5.9	(0.6)
11	1.1	(0.3)
12	8.9	(0.9)
13 or more	5.2	(0.7)
Total	100.0	

4. Preventive practices

Various preventive practices, such as deworming, are utilized to improve heifer growth and health. Common helminths (worms) that affect cattle are *Cooperia, Bunostomum, Strongyloides, Nematodirus, Toxocara, Oesophagostomum*, *Trichuris,* and the stomach worms *Ostertagia, Haemonchus,* and *Trichostrongylus*. Younger animals are more likely to have high worm burdens than adult animals, since they have not yet acquired immunity to these parasites (Yazwinski and Gibbs, 1975; Merck, 1998). Heavy worm burdens cause diminished growth, poor health, and decreased milk production in dairy cattle (Block and Gadbois, 1986; Bradley et al., 1986; Block et al., 1987). The goal of a deworming protocol is to decrease existing worm burdens and to prevent future infections by reducing parasite load in the pasture. Choosing an appropriate deworming protocol depends upon the seasonal pattern of helminth disease and pasture access of the herd. Deworming products can be rotated to reduce the chance of developing anthelmintic resistance.

Coccidia are another important group of parasites in dairy cattle. The species of Coccidia most likely to cause diarrhea and immunosuppression are *Eimeria bovis* and *Eimeria zuernii*. Coccidia are present in the

environment of both pastured and confinement-raised animals. A combination of stressed animals and eating off the ground tend to be the cause of most disease outbreaks. For calves, outbreaks can occur after weaning, dehorning, castration, or during cold weather. There are two classes of medications used to prevent coccidiosis in calves. Coccidoistats, such as Deccox (decoquinate) are one option. Ionophores are another method and have the added benefit of acting as growth promotants. In addition to being coccidiocidal, ionophores alter the rumen bacterial population, thereby changing the production of certain volatile fatty acids and facilitating more efficient use of feed. Common ionophores are lasalocid (Bovatec) and monensin (Rumensin). Ionophores have come under some scrutiny due to concerns about antimicrobial resistance. The USDA Food and Feed Safety Research Unit, Southern Plains Agricultural Research Center, reported in 2003 that the use of ionophores does not appear to contribute to antibiotic resistance to important human drugs (Callaway et al., 2003). The use of anticoccidial drugs in milk replacers and calf starter is recommended because these drugs increase growth rate and reduce health problems in calves (Anderson et al., 1988; Eicher-Pruiett et al., 1992; Heinrichs, 1993; Quigley et al., 1997).

Certain vitamins and minerals are often supplemented to prevent nutritional deficiencies in dairy cattle. Selenium, an essential trace mineral, is deficient in the soil and plants in some parts of the United States (Allaway, 1969). Selenium deficiency causes white muscle disease in calves; affected calves can have weakness, stiffness, and muscle tremors. Selenium deficiency also decreases overall growth and health in cattle, and increases the occurrence of mastitis and retained placentas in cows (Harrison et al., 1984; Smith et al., 1984; Kincaid, 1995). Selenium supplements can be added to feed in organic or inorganic forms. Sodium selenate and sodium selenite are the two inorganic forms of selenium; selenized yeast is an example of an organic source of selenium. Selenium can also be administered by injection. Vitamins A, D, and E are also essential to the health of dairy cattle. Chapters 6 and 7 of the "2001 Nutrient Requirements of Dairy Cattle" (National Research Council) give detailed recommendations for supplementing vitamins and minerals.

Anionic salts such as magnesium chloride and magnesium sulfate ($MgCl_2$, $MgSO_4$), ammonium chloride and ammonium sulfate (NH_4Cl, $(NH_4)_2SO_4$), and calcium chloride and calcium sulfate ($CaCl_2$, $CaSO_4$) are sometimes fed to dairy cows during the dry period to prevent hypocalcemia (milk fever). Although anionic salts are beneficial to cows, they are not recommended for heifers because parturient hypocalcemia is uncommon in heifers. Also, anionic salts are unpalatable, and feeding them to heifers can result in decreased dry matter intake, decreased energy balance, and lower body weight gains (Moore et al., 2000).

Probiotics are defined by the World Health Organization as "live microorganisms which when administered in adequate amounts confer a health benefit on the host" (FAO/WHO, 2001). *Lactobacillus acidophilus*, *Enterococcus faecium,* and *Bifidobacterium subtillus* are

common microorganisms that have been used as probiotics in dairy calves. Studies have shown that probiotics in some situations are effective for growth promotion and disease prevention in calves (Abe et al., 1995; Donovan et al., 2002; Khuntia and Chaudhary, 2002; Timmerman et al., 2005).

Preventive practices were used for heifers on almost all operations: 94.6 percent of operations administered at least one preventive practice to heifers, and 94.6 percent of heifers were on these operations. Nearly 7 of 10 operations (69.4 percent) dewormed heifers, and similar percentages of operations provided vitamins A-D-E or selenium in feed (74.4 and 69.3 percent, respectively).

Percentage of operations (and percentage of heifers on these operations) by preventive practices normally used for heifers

Preventive Practice	Percent Operations	Standard Error	Percent Heifers*	Standard Error
Dewormers	69.4	(1.3)	55.2	(1.5)
Coccidiostats in feed	46.5	(1.4)	56.5	(1.6)
Vitamins A-D-E injection	10.4	(0.7)	17.4	(1.3)
Vitamins A-D-E in feed	74.4	(1.2)	71.9	(1.5)
Selenium injection	13.2	(0.9)	17.2	(1.2)
Selenium in feed	69.3	(1.3)	65.4	(1.6)
Ionophores in feed (e.g., Rumensin®, Bovatec®)	45.2	(1.4)	58.1	(1.6)
Probiotics	20.0	(1.1)	27.7	(1.6)
Anionic salts in feed	20.9	(1.1)	28.1	(1.5)
Other	4.6	(0.7)	2.5	(0.4)
Any preventive	94.6	(0.7)	94.6	(0.9)

*As a percentage of January 1, 2007, heifer inventory.

5. Injection practices

Almost all operations gave injections to heifers (96.9 percent). More than 9 of 10 operations (94.0 percent) gave intramuscular (IM) injections to heifers , and approximately 5 of 10 operations (51.6 percent) administered intravenous (IV) injections to heifers.

a. Percentage of operations that administered injections to heifers during the previous 12 months, by injection route

Percent Operations*							
Injection Route							
Intramuscular		Subcutaneous		Intravenous		Any	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
94.0	(1.4)	62.2	(3.0)	51.6	(3.0)	96.9	(1.1)

*Operations with 30 or more dairy cows.

To restrain heifers while administering IM injections, operations primarily used lock-up (30.4 percent of operations), tie stall/stanchion (28.8 percent), or chute/head gate (22.6 percent) facilities. These same types of facilities also were primarily used for subcutaneous (SQ) and IV injections for heifers. Less than 11 percent of operations gave any injections to heifers loose in freestalls, in a palpation rail, or in the parlor.

b. For the 96.9 percent of operations that administered IM, SQ and/or IV injections to heifers, percentage of operations by type of cattle-handling facility primarily used, and by injection route

	Percent Operations*					
	Injection Route					
	Intramuscular		Subcutaneous		Intravenous	
Cattle-handling Facility Type	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Tie stall/stanchion	28.8	(2.9)	24.2	(3.4)	36.3	(4.1)
Lock-up	30.4	(2.5)	36.4	(3.3)	31.6	(3.6)
Chute/head gate	22.6	(2.5)	23.4	(2.8)	20.1	(3.0)
Loose in freestall	10.2	(2.0)	7.5	(2.1)	5.7	(1.7)
Palpation rail	0.3	(0.1)	0.5	(0.2)	0.2	(0.2)
Parlor	5.5	(1.2)	4.3	(1.3)	2.4	(1.2)
Other	2.2	(1.1)	3.7	(1.7)	3.7	(1.6)
Total	100.0		100.0		100.0	

*Operations with 30 or more dairy cows.

6. Vaccination practices

More than 60 percent of operations vaccinated heifers against bovine viral diarrhea (BVD), infectious bovine rhinotracheitis (IBR), parainfluenza Type 3 (PI3), bovine respiratory syncytial virus (BRSV), or leptospirosis. With the exception of IBR, PI3, BRSV, *Haemophilus somnus*, and *Mycobacterium* avium subspecies *paratuberculosis*, a higher percentage of large operations than medium or small operations vaccinated against the listed diseases. Less than half of operations (41.6 percent) normally vaccinated heifers against brucellosis. For heifers, a lower percentage of small operations vaccinated against each of the listed diseases than medium or large operations.

a. Percentage of operations that normally vaccinated heifers against the following diseases, by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Disease	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Bovine viral diarrhea (BVD)	69.0	(1.7)	84.5	(1.7)	94.1	(1.4)	73.7	(1.3)
Infectious bovine rhinotracheitis (IBR)	65.7	(1.7)	81.7	(1.8)	88.4	(1.8)	70.4	(1.3)
Parainfluenza Type 3 (PI3)	57.1	(1.8)	70.2	(2.1)	76.2	(2.4)	61.0	(1.4)
Bovine respiratory syncytial virus (BRSV)	60.6	(1.8)	75.4	(2.0)	80.8	(2.2)	64.9	(1.4)
Haemophilus somnus	31.1	(1.7)	42.4	(2.3)	43.0	(2.6)	34.2	(1.3)
Leptospirosis	63.2	(1.7)	78.1	(1.9)	86.7	(1.9)	67.7	(1.3)
Salmonella	15.5	(1.3)	34.4	(2.2)	52.5	(3.0)	21.5	(1.1)
E. coli mastitis	17.6	(1.4)	36.6	(2.2)	61.8	(3.0)	24.1	(1.1)
Clostridia	28.3	(1.6)	48.8	(2.2)	63.4	(2.9)	34.6	(1.3)
Brucellosis	37.4	(1.7)	49.5	(2.2)	66.7	(2.5)	41.6	(1.3)
Mycobacterium avium subspecies *paratuberculosis* (Johne's disease)	3.4	(0.7)	8.7	(1.3)	10.6	(2.1)	5.0	(0.6)
Neospora	3.8	(0.7)	11.3	(1.6)	20.5	(2.4)	6.3	(0.6)
Other	6.9	(0.9)	6.3	(1.0)	7.8	(1.4)	6.8	(0.7)
Any disease	79.3	(1.5)	92.0	(1.3)	97.1	(0.8)	83.0	(1.1)

Operations in the West region were more likely to vaccinate heifers for the majority of the listed diseases than operations in the East region. About twice the percentage of operations in the West than in the East region vaccinated against *Salmonella, E. coli* mastitis, clostridia, brucellosis, and *Neospora*. No regional differences in vaccination were seen for PI3, BRSV, *Haemophilus somnus*, and Johne's disease.

b. Percentage of operations that normally vaccinated heifers against the following diseases, by region

	Percent Operations			
	Region			
	West		East	
Disease	**Percent**	**Std. Error**	**Percent**	**Std. Error**
Bovine viral diarrhea (BVD)	85.6	(2.3)	72.8	(1.4)
Infectious bovine rhinotracheitis (IBR)	78.4	(2.7)	69.8	(1.4)
Parainfluenza Type 3 (PI3)	67.0	(3.0)	60.5	(1.5)
Bovine respiratory syncytial virus (BRSV)	72.3	(2.9)	64.4	(1.5)
Haemophilus somnus	36.6	(3.0)	34.1	(1.4)
Leptospirosis	78.8	(2.4)	66.9	(1.4)
Salmonella	41.5	(2.9)	20.0	(1.1)
E. coli mastitis	48.3	(2.9)	22.1	(1.2)
Clostridia	65.3	(3.0)	32.2	(1.3)
Brucellosis	87.0	(1.8)	38.0	(1.4)
Mycobacterium avium subspecies *paratuberculosis* (Johne's disease)	8.3	(1.7)	4.7	(0.6)
Neospora	17.9	(2.5)	5.4	(0.6)
Other	7.5	(1.8)	6.8	(0.7)
Any disease	97.8	(0.7)	81.2	(1.2)

7. Bovine viral diarrhea (BVD)

BVD infection in a dairy herd can result in large economic and production losses, primarily because of reproductive problems, decreased overall herd health, and decreased milk production (Houe, 1999; Heuer et al., 2007). BVD causes two types of infections in cattle: persistent infection and transient infection. Persistently infected animals become infected while *in utero*. These animals never clear the infection, so they shed large amounts of the virus continually throughout life. They are the primary source for transmitting transient infections to other members of the herd. Transiently infected animals are those animals infected with BVD following birth. These animals may be subclinical or they may have mild or severe symptoms such as diarrhea or decreased milk production, but they will eventually clear the virus and recover if the infection is not severe enough to be fatal. A persistently infected calf is produced if the dam is persistently infected or becomes transiently infected during pregnancy. In this way, the next generation of persistently infected animals is created and the cycle of BVD continues in the herd. Other possible outcomes when a cow is transiently infected during pregnancy include abortions and congenital (birth) defects.

Culling persistently infected cattle is a critical step in eliminating BVD from a dairy herd. According to the 2006 Academy of Veterinary Consultants position statement on the disposition of persistently infected cattle, “the marketing or movement of PIs in any manner that potentially exposes at-risk cattle is strongly discouraged.” Therefore, the persistent-infection status of cattle that are culled should be disclosed.

Some BVD persistently infected animals appear ill, but many show no obvious symptoms. There are several testing options for identifying persistently infected animals. One method of determining if a dam and her calf are persistently infected with BVD is to test the calf. Since a persistently infected cow will always produce a persistently infected calf, the dam is negative if the calf tests negative. However, a persistently infected calf does not necessarily mean that the dam is persistently infected. Ear notch testing is a popular method for identifying animals persistently infected with BVD, and ear notch tests are accurate for cattle of any age (Fulton et al., 2006). Ear notches can be tested with either IHC (immunohistochemistry) or antigen-capture ELISA; either method is acceptable. Alternatively, serum samples can be tested using virus isolation, antigen capture ELISA, or PCR. Serum samples have the disadvantage of not being able to distinguish persistent infection from transient infection with a single sample. Animals that test positive on the first serum sample will need to be retested in about 3 weeks to distinguish persistent infection from transient infection. Also, some serum tests are inaccurate in young animals, so they are best reserved for animals older than 2 to 3 months of age. PCR on whole blood is one blood test that can be used with accuracy in young calves (Larson et al., 2005).

Few operations (4.0 percent) routinely tested heifer replacements for persistent infection with BVD. The percentage of operations that tested and the percentage of heifers represented by these operations increased as herd size increased. More than 1 of 10 heifers (11.2 percent) were on operations that routinely tested for BVD.

a. Percentage of operations (and percentage of heifers on these operations) that routinely tested heifer replacements to determine if animals were persistently infected with BVD, by herd size

	Percent							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Population	Percent	Std. Error	Percent	Std. Error	Percent	Std. Error	Percent	Std. Error
Operations	1.9	(0.5)	6.7	(1.1)	21.2	(2.4)	4.0	(0.4)
Heifers	2.2	(0.5)	7.2	(1.2)	18.6	(2.2)	11.2	(1.1)

Of operations that tested heifers for persistent infection with BVD, the majority (66.8 percent) used individual ear notch tests, while 21.1 percent tested individual serum samples.

b. For the 4.0 percent of operations that routinely tested heifer replacements to determine if animals were persistently infected with BVD, percentage of operations by testing method used

Testing Method	Percent Operations	Standard Error
Individual ear notch	66.8	(5.7)
Pooled ear notch	11.4	(4.0)
Individual serum sample	21.1	(5.4)
Pooled serum sample	6.0	(3.0)
Other	6.5	(2.4)

Vaccination is an important management tool for controlling BVD and should be implemented along with a plan to test and remove persistently infected animals. There are two types of vaccines: modified live and killed. Killed vaccines contain inactivated virus mixed with substances that stimulate an immune response; modified live vaccines contain virus that has been modified so that it is unlikely to cause disease. The most notable advantage of modified live vaccines is that they provide quicker, stronger, and longer lasting immunity than killed vaccines. The biggest advantage of killed vaccines is their overall safety, especially for pregnant animals. The vaccination schedule should be designed to reduce reproductive losses and calf morbidity and mortality. If using a modified live vaccine, heifers should be vaccinated twice, at 3- to 4-week intervals about 60 days prior to breeding. Cows can then be boostered annually, 2 weeks before breeding. For killed vaccines, the second dose in the primary series for heifers should be given 2 weeks before breeding, and annual boosters for cows can still be given 2 weeks before breeding (Kelling, 2004). Although vaccination of the dam provides some degree of fetal protection, no vaccine has been shown to completely protect the fetus from persistent infection if the dam is exposed to BVD during pregnancy (Cortese et al., 1998; Kovacs et al., 2003; Ficken et al., 2006).

A higher percentage of operations administered modified live BVD vaccines than killed vaccines to heifers (62.2 percent and 43.1 percent, respectively).

c. For the 73.7 percent of operations that gave BVD vaccinations to heifers, percentage of operations by type of BVD vaccine given

Type of Vaccine	Percent Operations	Standard Error
Killed	43.1	(1.6)
Modified live	62.2	(1.5)

G. Surgical Procedures

Note: Estimates in the following tables represent only operations with 30 or more dairy cows.

1. Dehorning

Horns are removed from dairy cattle to reduce the risk of injury to people and other cattle. In young calves, horns start as buds located in the skin of the polls. The horn bud attaches to the skull adjacent to the frontal sinus when the calf is about 2 months of age. In adult cattle, a portion of the frontal sinus chamber extends into the horn. The cells that lie at the connection between the skin and the horn are called the corium; these cells produce the horn material.

Disbudding refers to the removal of the corium while the horn is still a bud, usually when the calf is 12 weeks of age or less. Disbudding is preferred over dehorning because it is less likely to cause a setback in calf growth (Loxton et al., 1982; Laden et al., 1985), and is less likely to cause complications such as bleeding or sinus infection. Caustic paste (chemical cauterization), hot irons (heat cauterization), and dehorning spoons or tubes (scooping techniques) are all used for disbudding calves. Chemical cauterization can be accomplished by applying a paste that contains sodium hydroxide or calcium hydroxide to the horn buds. Caustic paste works best if calves are less than 3 weeks of age and individually housed. Caution must be exercised to ensure that the caustic paste does not get into the calf's eyes or on its skin. Rather than destroying the corium with heat or chemicals, scooping techniques remove it.

Dehorning is the term used to describe removal of the horns at an older age, when the horns have already started to develop. Chemical or heat cauterization is not effective at this stage, so the horn must be physically removed. Typical techniques for dehorning include the Barnes scoop dehorner and the use of wire or saws. If any part of the corium is left behind during dehorning or disbudding, the horn tissue will grow back. For simplicity, the term dehorning will be used to refer to both disbudding and dehorning for the remainder of this discussion.

Dehorning causes behavioral and physiological signs of pain in calves. Studies have shown that dehorning results in behavioral signs of discomfort, such as head shaking, head rubbing, tail flicking, and ear flicking. In addition, dehorning causes increased blood levels of cortisol, a stress hormone, for 6 to 8 hours after the procedure (Morisse et al., 1995; McMeekan et al., 1997; McMeekan et al., 1998; Graf and Senn, 1999; Groendahl-Nielsen et al., 1999; Faulkner and Weary, 2000; Doherty et al., 2007). In the United States, there are no regulations concerning dehorning procedures. The American Veterinary Medical Association's Animal Welfare Division states "Both dehorning and castration should be done at the earliest age practicable. Disbudding is the preferred method of dehorning calves. Local anesthetic should be considered for other dehorning procedures." In the European Union, it is illegal to disbud or dehorn calves over 14 days of age without using a local anesthetic.

Local anesthesia has been advocated to reduce the pain of dehorning. Each horn can be desensitized by an injection of local anesthetic near the cornual nerve. Lidocaine, a frequently used local anesthetic, provides local anesthesia for about 2 hours. Most studies on the benefits

of lidocaine suggest that it is effective in reducing the behavioral and physiological signs of pain for the duration of effect of the anesthetic. Sylvester et al. (2004) showed that 6-month-old calves that received lidocaine had a decrease in behavioral signs of pain for 2 hours after dehorning. After 2 hours, the signs of pain were comparable to calves that did not receive lidocaine. In addition, several studies have shown that local anesthesia temporarily reduced or prevented the rise in plasma cortisol levels after dehorning in a variety of age groups. However, the effect only lasted as long as the anesthesia; when the local anesthetic wore off, cortisol levels increased (Petrie et al., 1996; McMeekan et al., 1998; Sutherland et al., 2002). It should be noted that lidocaine does not appear to be effective for pain relief when caustic paste is used for disbudding, perhaps because the pH of the paste interferes with the lidocaine (Vickers et al., 2005).

The use of local anesthesia with ketoprofen, a nonsteroidal anti-inflammatory drug (NSAID) nearly eliminated the postdehorning rise in cortisol in 3- to 4-month-old calves when used prior to scoop dehorning (McMeekan et al. (1998). However, ketoprofen is not approved by the FDA for use in food animals in the United States. Flunixin meglumine is the only NSAID approved for use in cattle in the United States, and it is approved only for the treatment of mastitis, endotoxemia, or respiratory disease. Future research to determine if flunixin meglumine would also be effective as an analgesic for dehorning would be useful.

The use of xylazine, a sedative and mild analgesic, has also been investigated for dehorning calves (Ley et al., 1990); however, xylazine is not approved by the FDA for use in food animals in the United States. When a sedative, a local anesthetic, and ketoprofen were combined, behavioral signs of pain were greatly reduced for calves dehorned with a hot iron. In fact, calves did not even require restraint for the dehorning procedure when this protocol was used (Faulkner and Weary, 2000). However, a multiple-injection protocol such as this may not be practical for many operations. For operations wanting a simpler approach, Vikers et al. (2005) reported that the pain from the use of caustic paste was adequately controlled with xylazine alone.

Considering the challenges of using pharmaceuticals (cost and availability of approved drugs) to reduce pain during dehorning, selective breeding for polled stock may be an attractive alternative for the dairy industry.

Overall, 94.0 percent of operations routinely dehorned heifer calves while they were on the operation during the previous 12 months. A lower percentage of large operations (64.3 percent) dehorned heifer calves than small or medium operations (97.3 and 92.6 percent, respectively). More than 95 percent of operations in the East region (95.6 percent) routinely dehorned heifer calves, compared with 77.6 percent of operations in the West region. Herd-size and regional differences are likely related to large operations moving calves to heifer-raising facilities when calves are still too young for disbudding/dehorning.

a. Percentage of operations that routinely dehorned heifer calves while on the operation during the previous 12 months, and by herd size

Percent Operations							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
97.3	(1.6)	92.6	(2.8)	64.3	(6.3)	94.0	(1.4)

b. Percentage of operations that routinely dehorned heifer calves while on the operation during the previous 12 months, by region

Percent Operations			
Region			
West		East	
Percent	Standard Error	Percent	Standard Error
77.6	(4.6)	95.6	(1.4)

For operations that routinely dehorned heifer calves during the previous 12 months, more than two-thirds (69.1 percent) used a hot iron; 28.2 percent used a tube, spoon, or gouge; and 16.3 percent used saws, wire, or Barnes dehorners. For operations that used a hot iron to dehorn calves, 13.8 percent used analgesics/anesthetics when dehorning calves.

c. For the 94.0 percent of operations that routinely dehorned heifer calves during the previous 12 months, percentage of operations by dehorning method, and corresponding percentage of operations using that method in tandem with analgesics/anesthetics

Method	Percent Operations	Std. Error	Percent Operations that Used Analgesics/ Anesthetics	Std. Error
Hot iron	69.1	(2.8)	13.8	(2.6)
Caustic paste	9.2	(1.8)	14.2	(5.8)
Tube, spoon, or gouge	28.2	(2.9)	21.5	(5.1)
Saws, wire, or Barnes	16.3	(2.3)	21.5	(6.7)
Other	1.7	(0.9)	17.1	(16.5)

Photo courtesy of Dairy Herd Management/Bovine Veterinarian

The majority of heifer calves (67.5 percent) were dehorned using a hot iron at an average age of 7.6 weeks. Caustic paste was used on 12.2 percent of calves at an average age of 2.7 weeks. A similar percentage was observed for the tube-spoon-or gouge method, but average age increased to 16.9 weeks. Saws, wire, or Barnes dehorning was performed on 7.1 percent of heifer calves at an average age of 23.5 weeks.

d. For the 94.0 percent of operations that routinely dehorned heifer calves during the previous 12 months, percentage of calves dehorned and operation average age at dehorning, by method used to dehorn calves

Method	Percent Heifers*	Std. Error	Operation Average Age (Weeks)	Std. Error
Hot iron	67.5	(3.1)	7.6	(0.4)
Caustic paste	12.2	(2.6)	2.7	(0.3)
Tube, spoon, or gouge	13.0	(1.7)	16.9	(1.2)
Saws, wire, or Barnes	7.1	(1.1)	23.5	(2.6)
Other	0.2	(0.1)	32.7	(6.9)
Total	100.0			

*Dairy heifer calves weaned during the previous 12 months.

Of the dehorning equipment used on operations, tubes, spoons, gouges, saws, wire, and Barnes dehorners commonly cause bleeding. More than 4 of 10 operations (42.0 percent) used dehorning equipment that causes bleeding. A higher percentage of small and medium operations (42.9 and 43.5 percent, respectively) used dehorning equipment that causes bleeding compared with large operations (18.9 percent).

e. For the 94.0 percent of operations that routinely dehorned heifer calves while on the operation during the previous 12 months, percentage of operations that dehorned heifer calves with equipment that can cause bleeding, by herd size

Percent Operations

Herd Size (Number of Cows)

Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
42.9	(4.0)	43.5	(4.6)	18.9	(5.7)	42.0	(3.1)

Disinfecting dehorning equipment that causes bleeding reduces the possibility of transmitting diseases such as bovine leukosis virus. Of the operations that used dehorning equipment that causes bleeding, 46.4 percent disinfected dehorning equipment for each calf.

f. For operations that routinely dehorned heifer calves with equipment that can cause bleeding, percentage of operations that chemically disinfected surgical dehorning equipment for each calf

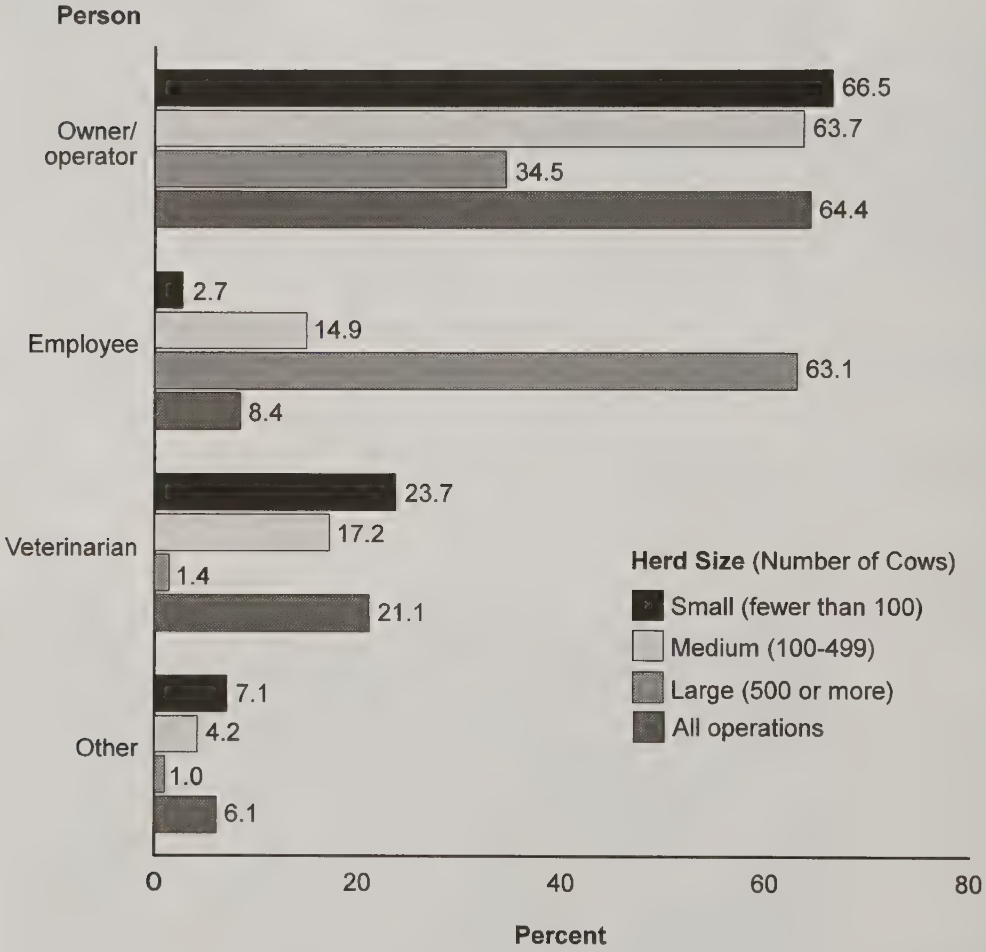
Percent Operations	Standard Error
46.4	(4.9)

On almost two-thirds of operations (64.4 percent), the owner/operator dehorned the majority of calves. The person who dehorned the majority of calves differed with operation size, however, with the owner/operator dehorning the majority of heifer calves on about two-thirds of small and medium operations (66.5 percent and 63.7 percent, respectively) but only on about one-third of large operations (34.5 percent). An employee dehorned the majority of calves on 63.1 percent of large operations, compared with 2.7 percent of small operations and 14.9 percent of medium operations. Veterinarians performed the majority of dehorning on 23.7 percent of small operations, 17.2 percent of medium operations, and 1.4 percent of large operations.

g. For the 94.0 percent of operations that routinely dehorned heifer calves during the previous 12 months, percentage of operations by person who dehorned the majority of heifer calves on the operation, and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Person	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Owner/operator	66.5	(3.8)	63.7	(4.2)	34.5	(7.5)	64.4	(2.9)
Employee	2.7	(1.1)	14.9	(2.9)	63.1	(7.4)	8.4	(1.1)
Veterinarian	23.7	(3.4)	17.2	(3.4)	1.4	(0.5)	21.1	(2.6)
Other	7.1	(2.2)	4.2	(1.8)	1.0	(0.6)	6.1	(1.6)
Total	100.0		100.0		100.0		100.0	

For the 94.0 Percent of Operations that Routinely Dehorned Heifer Calves During the Previous 12 Months, Percentage of Operations by Person Who Dehorned the Majority of Heifer Calves on the Operation, and by Herd Size



Employees dehorned the majority of heifer calves on a higher percentage of operations in the West region (33.4 percent) than in the East region (6.4 percent), which may be due to the larger operations in the West.

h. For the 94.0 percent of operations that routinely dehorned heifer calves during the previous 12 months, percentage of operations by person who dehorned the majority of heifer calves on the operation, and by region

	Percent Operations			
	Region			
	West		East	
Person	Percent	Std. Error	Percent	Std. Error
Owner/operator	55.1	(6.8)	65.2	(3.1)
Employee	33.4	(5.5)	6.4	(1.1)
Veterinarian	11.5	(4.6)	21.8	(2.8)
Other	0.0	(--)	6.6	(1.8)
Total	100.0		100.0	

2. Extra teat removal

Extra teats on dairy cows can interfere with milking and lead to mastitis, and they are not acceptable in show cattle. As with dehorning, removing extra teats at an early age is usually less painful for calves and helps to ensure a quick recovery.

About one-half of operations (50.3 percent) routinely removed extra teats from heifer calves during the previous 12 months. The percentage of operations that removed extra teats did not differ by herd size.

a. Percentage of operations that routinely removed extra teats from heifer calves during the previous 12 months, by herd size

Percent Operations							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
46.4	(4.0)	57.1	(4.4)	66.4	(6.2)	50.3	(3.0)

About one-fifth of operations (20.3 percent) that routinely removed extra teats from heifer calves removed the teats when the heifers were less than 12 weeks old, while one-third (32.2 percent) removed teats at 12.0 to 17.9 weeks of age. About 20 percent of operations removed extra teats from animals in each of the next two age categories (18.0 to 23.9 weeks and 24.0 to 29.9 weeks).

b. For the 50.3 percent of operations that routinely removed extra teats from heifer calves during the previous 12 months, percentage of operations by age at which extra teats were removed

Age (Weeks)	Percent Operations	Standard Error
Less than 12.0	20.3	(3.4)
12.0 to 17.9	32.2	(3.8)
18.0 to 23.9	20.1	(3.4)
24.0 to 29.9	18.6	(3.5)
30.0 or more	8.8	(1.9)
Total	100.0	

One of 10 operations (10.6 percent) routinely used analgesia or anesthesia during extra teat removal, which is similar to usage for dehorning.

c. For the 50.3 percent of operations that routinely removed extra teats from heifer calves during the previous 12 months, percentage of operations that used analgesics or anesthesia to remove extra teats

Percent Operations	Standard Error
10.6	(3.0)

3. Tail docking

Tail docking was initially promoted to reduce the incidence of leptospirosis in milking personnel in New Zealand, but subsequent research demonstrated leptospiral titers of milkers had no relationship with tail docking. Tail docking is currently prohibited California and must not be performed as a routine management procedure in the European Union.

The AVMA is opposed to tail docking, and the American Association of Bovine Practitioners (AABP) states the following: “The AABP is not aware of sufficient scientific evidence in the literature to support tail docking in cattle. If it is deemed necessary for proper care and management of production animals in certain conditions, veterinarians should counsel clients on proper procedures, benefits and risks.”

About half of operations (51.4 percent) had no cows with the tail docked. A higher percentage of operations in the West region (81.3 percent) had no cows with the tail docked than in the East region (48.5 percent of operations). On about one of seven operations (14.6 percent), all cows had the tail docked.

a. Percentage of operations by percentage of dairy cows with the tail docked, and by region

	Percent Operations					
	Region					
	West		East		All Operations	
Percent Cows	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
0	81.3	(4.3)	48.5	(3.2)	51.4	(2.9)
0.1 to 24.9	0.7	(0.7)	11.8	(2.0)	10.8	(1.9)
25.0 to 75.9	9.6	(3.7)	8.8	(1.7)	8.9	(1.6)
76.0 to 99.9	5.5	(1.9)	15.1	(2.4)	14.3	(2.2)
100.0	2.9	(1.5)	15.8	(2.2)	14.6	(2.0)
Total	100.0		100.0		100.0	

Overall, about 4 of 10 cows (38.8 percent) had the tail docked. A higher percentage of cows on medium operations (55.5 percent) than on small or large operations (27.1 and 34.5 percent, respectively) had the tail docked.

b. Percentage of cows with the tail docked, and by herd size:

Percent Cows*							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
27.1	(3.2)	55.5	(3.6)	34.5	(4.3)	38.8	(2.4)

*As a percentage of cows on the operation at the time of VS Initial Visit interview.

The majority of operations that had cows with the tail docked most commonly used a band to dock tails (87.2 percent); these operations represented 90.4 percent of cows with the tail docked. About 1 of 10 operations did not know what procedure was used, which suggests that the cattle were purchased with the tail already docked.

c. For the 48.6 percent of operations with tail-docked cows, percentage of operations (and percentage of tail-docked cows on these operations) by procedure most commonly used to dock tails

Procedure	Percent Operations	Std. Error	Percent Tail-Docked Cows	Std. Error
Band	87.2	(2.9)	90.4	(2.9)
Surgical removal	2.0	(1.0)	5.2	(2.4)
Hot knife	0.0	(--)	0.0	(--)
Other	1.9	(0.9)	2.7	(1.2)
Unknown procedure	8.9	(2.7)	1.7	(1.2)
Total	100.0		100.0	

Of operations with tail-docked cows, 61.0 percent (accounting for 38.0 percent of cows with the tail docked) performed tail-docking on the majority of animals when they were 2 years of age or older. The tail was docked on almost 3 of 10 cows (28.1 percent) when they were less than 2 months of age. About 10 percent of operations docked tails when cattle were less than 2 months of age (10.2 percent) or from 2 months to less than 6 months of age (10.5 percent).

d. For the 48.6 percent of operations with tail-docked cows, percentage of operations (and percentage of tail-docked cows on these operations) by age of the majority of animals when the tail was docked

Age	Percent Operations	Std. Error	Percent Tail-Docked Cows	Std. Error
Less than 2 months	10.2	(2.0)	28.1	(5.0)
2 to less than 6 months	10.5	(2.6)	17.1	(3.4)
6 months to less than 2 years	9.5	(2.0)	16.3	(3.5)
2 years or older	61.0	(4.0)	38.0	(4.9)
Unknown	8.8	(2.7)	0.5	(0.2)
Total	100.0		100.0	

The majority of operations with tail-docked cows (90.3 percent) did not routinely use analgesics or anesthetics for tail docking, compared with 1.1 percent that routinely used analgesics or anesthetics. Operations that routinely used analgesics or anesthetics represented 0.9 percent of cows with the tail docked.

e. For the 48.6 percent of operations with tail-docked cows, percentage of operations (and percentage of tail-docked cows on these operations) that routinely used analgesia or anesthesia

	Percent Operations	Std. Error	Percent Tail-Docked Cows	Std. Error
Yes	1.1	(0.6)	0.9	(0.6)
Don't know	8.6	(2.6)	1.3	(0.6)
No	90.3	(2.7)	97.8	(0.9)
Total	100.0		100.0	

H. Biosecurity

Note: Estimates in the following tables represent operations with any dairy cows.

1. Introduction

Because infectious diseases can cause tremendous economic losses for dairy operations, biosecurity practices to prevent and control disease are an essential aspect of raising replacement heifers. Biosecurity on dairy operations results from implementing management practices designed to prevent the introduction of disease-causing agents onto the operation. Biocontainment is the result of implementing strategies designed to prevent the spread of disease agents between animal groups (Wells, 2000; Dargatz et al., 2002). Strategies directed at both biosecurity and biocontainment are necessary to minimize potential impacts of disease on dairy operations. These strategies are particularly important for calves because preweaned calves are the animals most susceptible to disease.

Recognizing and understanding all aspects of potential biosecurity breaches are important when managing a successful biosecurity program. Generally, the issues that receive the most attention are: the process of introducing new animals onto the farm, including knowledge of their source and health history; isolating new animals from the main herd, and testing them for appropriate diseases; designing strategic vaccination programs; and hygiene practices, including disinfecting equipment and manure management. However, many other key components of infectious disease control are often overlooked. For example, minimizing stress helps animals better resist and combat disease. Animal stress can be reduced by providing a comfortable, clean environment, sufficient housing space, adequate bunk space, and by segregating cattle into appropriate age and/or size groups. For calves, providing high quality colostrum, quality feed and water, maintaining adequate nutrient intake, and providing clean housing help to decrease nutritional stress and ensure optimal immune function for disease resistance. Managing and regulating visitor, service personnel, employee, and animal traffic are also essential aspects of biosecurity. For instance, workers should care for calves before they care for older animals on the operation, and the number of visitors should be limited (Wallace, 2001; McCluskey, 2002).

2. Source of heifer inventory

Although 4.7 percent of operations had heifers born on the operation but raised elsewhere, these operations accounted for 11.5 percent of all heifers. Of the remaining heifers, 87.4 percent were born and raised on the operation, and nearly all operations (96.5 percent) had at least some dairy heifers born and raised on the operation.

Percentage of operations and percentage of heifers, by source of heifers

Heifer Source	Percent Operations	Standard Error	Percent Heifers*	Standard Error
Born and raised on operation	96.5	(0.4)	87.4	(1.2)
Born on operation raised off operation	4.7	(0.5)	11.5	(1.2)
Born off operation	6.6	(0.8)	1.1	(0.2)
Total			100.0	

*As a percentage of January 1, 2007, heifer inventory.

3. Animals brought onto the operation

The introduction of new animals can introduce diseases to the herd, especially if the new additions are not properly screened for disease prior to introduction. Almost 4 of 10 operations (38.9 percent) brought at least 1 new addition onto the operation during 2006. Approximately one of eight operations (12.2 percent) brought on bred dairy heifers. A lower percentage of large operations brought on preweaned calves compared with small operations (1.0 and 3.8 percent, respectively), but a higher percentage of large operations brought on dairy heifers, bred dairy heifers, or any beef or dairy cattle compared with medium or small operations.

a. Percentage of operations that brought the following classes of cattle onto the operation during 2006, by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Cattle Class	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Preweaned calves (dairy or beef)	3.8	(0.8)	2.5	(0.6)	1.0	(0.3)	3.4	(0.6)
Dairy heifers (weaned but not bred)	5.3	(0.8)	7.6	(1.2)	16.3	(2.6)	6.4	(0.7)
Bred dairy heifers	8.9	(1.0)	18.1	(1.8)	34.7	(2.6)	12.2	(0.9)
Any cattle (dairy or beef)	35.6	(1.7)	44.3	(2.3)	61.6	(2.8)	38.9	(1.4)

Although more operations in the West region brought on animals during 2006 than operations in the East region (49.3 and 38.0 percent, respectively), a higher percentage of operations in the East region brought on preweaned calves.

b. Percentage of operations that brought the following classes of cattle onto the operation during 2006, by region

	Percent Operations			
	Region			
	West		East	
Cattle Class	Percent	Std. Error	Percent	Std. Error
Preweaned calves (dairy or beef)	0.6	(0.3)	3.6	(0.6)
Dairy heifers (weaned but not bred)	12.6	(2.2)	5.9	(0.7)
Bred dairy heifers	21.1	(2.3)	11.5	(0.9)
Any cattle (dairy or beef)	49.3	(3.0)	38.0	(1.5)

For operations that introduced bred heifers, the percentage of cow inventory brought on as bred heifers was similar across herd sizes, ranging from 15.1 percent of small operations to 17.3 percent of large operations.

c. For the 12.2 percent of operations that brought bred heifers onto the operation during 2006, percentage* of cow inventory that was brought on as bred heifers, by herd size

Percent Cow Inventory*							
Herd Size (Number of Cows)							
Small (Fewer than 100)		Medium (100-499)		Large (500 or More)		All Operations	
Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
15.1	(1.7)	15.6	(1.8)	17.3	(1.4)	16.7	(1.1)

*As a percentage of January 1, 2007, cow inventory.

4. Quarantine of herd additions

Bred dairy heifers were quarantined on less than 20 percent of operations (14.5 percent). Approximately one of five operations (20.3 percent) that brought cattle onto the operation during 2006 quarantined new additions.

For operations that brought the following classes of cattle onto the operation during 2006, percentage of operations that quarantined the following classes of cattle upon arrival, percentage of arriving cattle quarantined, and operation average number of days quarantined

Cattle Class	Percent Operations	Std. Error	Percent Cattle Quarantined	Std. Error	Operation Average Days Quarantined	Std. Error
Preweaned calves (dairy or beef)	44.2	(8.3)	20.1	(12.6)	42.4	(4.8)
Dairy heifers (weaned but not bred)	23.0	(4.7)	7.1	(2.6)	20.0	(3.6)
Bred dairy heifers	14.5	(2.3)	19.7	(3.5)	22.0	(3.1)
Any cattle (dairy or beef)	20.3	(1.7)	16.7	(2.4)	31.2	(3.5)

5. Calf contact with other cattle

Separating calves from older animals is an effective management practice used to reduce disease exposure of preweaned calves. Seventy-six percent of operations, representing 84.4 percent of calves, did not allow preweaned calves to have physical contact with weaned calves, and about 85 percent of operations did not allow contact with either bred heifers or adult cattle. More than two of three operations (69.5 percent), representing 78.7 percent of heifer calves, did not allow preweaned calves to have contact with older cattle.

Percentage of operations (and percentage of heifer calves born on these operations) in which after separation from the dam preweaned heifer calves did not have physical contact* with the following cattle classes

Cattle Class	Percent Operations	Std. Error	Percent Calves	Std. Error
Weaned calves not yet of breeding age	76.0	(1.2)	84.4	(1.1)
Bred heifers not yet calved	86.8	(1.0)	91.3	(0.8)
Adult cattle	84.3	(1.1)	89.2	(0.9)
No contact with above classes	69.5	(1.3)	78.7	(1.2)

*Physical contact is defined as nose-to-nose contact or sniffing/touching/licking each other, including through a fence.

I. Health

Note: In this report antibiotic and antimicrobials are used synonymously (see Terms Used in This Report, p 4). A list of antibiotics and their respective classes are provided in Appendix III. Also, Estimates in the following tables represent only operations with 30 or more dairy cows.

1. Morbidity and antibiotic use in preweaned heifers

Almost one of four preweaned heifers had diarrhea (23.9 percent), and 17.9 percent of all preweaned heifers were treated with antibiotics for diarrhea. A lower percentage of preweaned heifers had respiratory disease (12.4 percent), and 11.4 percent of preweaned heifers were treated with antibiotics for respiratory disease.

a. Percentage of preweaned heifers affected and treated with antibiotics for a disease or disorder during the previous 12 months

	Percent Preweaned Heifers*			
	Affected		Treated	
Disease or Disorder	Percent	Std. Error	Percent	Std. Error
Respiratory	12.4	(1.3)	11.4	(1.3)
Diarrhea or other digestive problem	23.9	(1.9)	17.9	(1.7)
Navel infection	1.6	(0.2)	1.5	(0.2)
Other	0.6	(0.2)	0.6	(0.2)

*As a percentage of dairy heifer calves born alive in 2006.

More than 9 of 10 of calves affected with respiratory disease or navel infection were treated with an antibiotic (93.4 and 92.3 percent, respectively). Almost three-fourths of preweaned calves affected with diarrhea (74.5 percent) were treated with an antibiotic.

b. For preweaned heifers affected with a disease or disorder during the previous 12 months, percentage of preweaned heifers treated with an antibiotic

Disease or Disorder	Percent Affected Preweaned Heifers Treated	Standard Error
Respiratory	93.4	(2.3)
Diarrhea or other digestive problem	74.5	(4.8)
Navel infection	92.3	(2.4)
Other	97.2	(1.9)

Two-thirds of operations (66.7 percent) used an antibiotic to treat respiratory disease in preweaned heifers, and almost one-third (31.9 percent) had no respiratory disease in preweaned heifers. The primary antibiotics used to treat respiratory disease were florfenicol, macrolides, and noncephalosporin beta-lactams (18.3, 15.2, and 11.6 percent of operations, respectively). More than 6 of 10 operations (62.1 percent) treated preweaned heifers with antibiotics for diarrhea, while 17.4 percent of operations with preweaned heifers that had diarrhea did not treat these animals with antibiotics. The most commonly used primary antibiotics used for diarrhea were tetracycline, "other," noncephalosporin beta-lactams, and sulfonamides (16.2, 10.5, 9.4, and 9.2 percent, of operations, respectively). The primary antibiotics from the "other" category included trimethoprim sulfamethoxazole, amprolium, and lincomycin/spectinomycin. Navel infection was treated on 28.7 percent of operations, and the primary antibiotics used were noncephalosporin beta-lactams (21.2 percent of operations). Less than 5 percent of operations (4.5 percent) treated for other diseases.

c. Percentage of operations (including those not reporting diseases or disorders) by primary antibiotic used to treat preweaned heifers during the previous 12 months, and by disease or disorder treated

	Percent Operations							
	Disease/Disorder							
	Respiratory		Diarrhea*		Navel Infection		Other	
Primary Antibiotic Used	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Aminocyclitol	0.0	(0.0)	1.7	(0.7)	0.0	(--)	0.0	(--)
Aminoglycoside	0.6	(0.4)	4.0	(1.1)	0.0	(0.0)	0.4	(0.4)
Noncephalosporin beta-lactam	11.6	(2.0)	9.4	(1.8)	21.2	(2.5)	1.4	(0.7)
Cephalosporin	8.2	(1.5)	5.6	(1.1)	2.2	(0.6)	0.5	(0.4)
Florfenicol	18.3	(2.2)	4.0	(1.1)	1.1	(0.5)	0.0	(0.0)
Macrolide	15.2	(2.1)	1.5	(0.5)	0.8	(0.4)	0.3	(0.2)
Sulfonamide	1.9	(0.7)	9.2	(1.5)	0.9	(0.9)	0.2	(0.1)
Tetracycline	8.9	(1.7)	16.2	(2.3)	1.4	(0.4)	1.0	(0.6)
Other/unknown	2.0	(0.7)	10.5	(1.8)	1.1	(0.6)	0.7	(0.5)
Any antibiotic	66.7	(2.8)	62.1	(2.8)	28.7	(2.6)	4.5	(1.1)
No treatment but disease	1.4	(0.6)	17.4	(2.2)	2.5	(0.7)	0.2	(0.2)
No disease or disorder	31.9	(2.8)	20.5	(2.4)	68.8	(2.7)	95.3	(1.2)
Total	100.0		100.0		100.0		100.0	

*Or other digestive problem.

NOTE: To determine the percentage of treated preweaned heifers, the primary antibiotic used by the operation to treat a specific disease or disorder was applied to all treated heifers on the operation.

The majority of preweaned heifers treated for respiratory disease were on operations that used florfenicol, cephalosporins, macrolides, or tetracycline as the primary antibiotic to treat respiratory disease (25.4, 24.6, 19.8, and 13.2 percent of preweaned heifers, respectively). To treat diarrhea, sulfonamides, tetracycline, and "other" were the antibiotics used on operations for the highest percentage of preweaned heifers.

d. Of preweaned heifers treated with antibiotics during the previous 12 months, percentage of preweaned heifers by primary antibiotic used on the operation for the following diseases/disorders

	Percent Treated Preweaned Heifers					
	Disease/Disorder					
	Respiratory		Diarrhea*		Navel Infection	
Primary Antibiotic Used	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Aminocyclitol	0.1	(0.1)	5.1	(2.0)	0.0	(--)
Aminoglycoside	2.4	(1.7)	11.5	(3.9)	0.3	(0.2)
Noncephalosporin beta-lactam	7.9	(2.1)	11.0	(2.8)	69.6	(7.9)
Cephalosporin	24.6	(8.5)	9.5	(2.3)	5.0	(1.7)
Florfenicol	25.4	(5.5)	5.2	(1.8)	3.7	(2.0)
Macrolide	19.8	(3.7)	2.8	(1.6)	11.6	(8.9)
Sulfonamide	3.3	(1.8)	23.3	(6.2)	1.8	(1.8)
Tetracycline	13.2	(3.3)	16.5	(2.9)	6.7	(3.2)
Other	3.3	(1.5)	15.1	(3.0)	1.3	(0.6)
Total	100.0		100.0		100.0	

*Or other digestive problem.

2. Morbidity and antibiotic use in weaned heifers

Ionophores have not consistently been considered antibiotics, but according to Food and Drug Administration guidelines ionophores are a type of antibiotic. More than one-half of operations (50.9 percent) used antibiotics in rations for weaned heifers, including 32.7 percent that used only ionophores.

a. Percentage of operations by use of antibiotics in weaned-heifer rations during the previous 12 months to prevent disease or promote growth

Usage	Percent Operations	Standard Error
Antibiotics (other than ionophores) in heifer ration	18.2	(2.0)
Ionophores only in heifer ration	32.7	(2.6)
Did not know if antibiotics were in heifer ration	2.3	(0.9)
No antibiotics in heifer ration	44.2	(2.8)
No weaned heifers on operation	2.6	(0.8)
Total	100.0	

The majority of operations that used antibiotics in weaned heifer rations used ionophores (84.9 percent) followed by chlortetracycline (14.4 percent) and oxytetracycline compounds (10.9 percent).

b. For the 50.9 percent of operations that used antibiotics in rations for weaned dairy heifers during the previous 12 months, percentage of operations by antibiotic used

Antibiotic Used	Percent Operations	Std. Error
Bacitracin methylene disalicylate	0.0	(--)
Bambermycin	0.5	(0.5)
Chlortetracycline compounds	14.4	(2.3)
Neomycin sulfate	4.1	(1.8)
Ionophores	84.9	(2.8)
Neomycin-oxytetracycline	5.4	(1.9)
Oxytetracycline compounds	10.9	(2.2)
Sulfamethazine	5.7	(1.5)
Tylosin phosphate	0.0	(--)
Virginiamycin	0.2	(0.2)
Other antibiotics	2.0	(1.4)

Few weaned heifers were affected by or treated for disease. Only 5.9 percent of weaned heifers were recognized as having respiratory disease, and 5.5 percent of all weaned heifers were treated with antibiotics for respiratory disease. Diarrhea was reported in 1.9 percent of weaned heifers, and 1.6 percent of all weaned heifers were treated. Less than 2 percent of weaned heifers had other diseases or disorders.

c. Percentage of weaned heifers affected and treated with antibiotics for a disease or disorder during the previous 12 months

	Percent Weaned Heifers*			
	Affected		Treated	
Disease or Disorder	Percent	Std. Error	Percent	Std. Error
Respiratory	5.9	(0.5)	5.5	(0.5)
Diarrhea or other digestive problem	1.9	(0.7)	1.6	(0.7)
Other	1.7	(0.6)	1.4	(0.6)

*As a percentage of weaned heifer inventory on January 1, 2007.

More than 9 of 10 weaned heifers affected with respiratory disease (93.3 percent) were treated with antibiotics. About 8 of 10 weaned heifers with diarrhea or other digestive problems (85.4 percent) were treated with antibiotics.

d. For weaned heifers affected with a disease or disorder during the previous 12 months, percentage of weaned heifers treated with an antibiotic

Disease or Disorder	Percent Affected Weaned Heifers Treated	Standard Error
Respiratory	93.3	(1.8)
Diarrhea or other digestive problem	85.4	(7.8)
Other	81.3	(8.9)

Almost one-half of operations (49.2 percent) treated some weaned heifers for respiratory disease, while only 7.4 percent treated for diarrhea and 6.2 percent for other diseases. The primary antibiotics used on operations for respiratory disease in weaned heifers were florfenicol and tetracycline (12.4 and 11.0 percent of operations, respectively). Antibiotics used to treat diarrhea in weaned calves included "other" (primarily amprolium), noncephalosporin beta-lactams, and tetracycline. Other diseases were treated with noncephalosporin beta-lactams and tetracycline on 3.3 and 1.9 percent of operations, respectively.

e. Percentage of operations (including those not reporting diseases or disorders) by primary antibiotic used to treat weaned heifers during the previous 12 months, and by disease or disorder

	Percent Operations					
	Disease/Disorder					
	Respiratory		Diarrhea*		Other	
Primary Antibiotic Used	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Aminocyclitol	0.4	(0.2)	0.0	(--)	0.0	(--)
Aminoglycoside	0.0	(--)	0.2	(0.1)	0.0	(--)
Noncephalosporin beta-lactam	7.8	(1.6)	1.6	(0.8)	3.3	(1.1)
Cephalosporin	4.5	(1.3)	0.7	(0.2)	0.2	(0.2)
Florfenicol	12.4	(1.7)	0.4	(0.2)	0.0	(--)
Macrolide	8.0	(1.2)	0.2	(0.2)	0.2	(0.2)
Sulfonamide	1.5	(0.5)	0.4	(0.1)	0.2	(0.1)
Tetracycline	11.0	(1.7)	1.4	(0.5)	1.9	(0.6)
Other	3.6	(1.1)	2.5	(0.7)	0.4	(0.2)
Any antibiotic	49.2	(2.9)	7.4	(1.3)	6.2	(1.3)
No treatment but disease	5.1	(1.4)	4.2	(1.1)	4.7	(1.5)
No disease	45.7	(2.9)	88.4	(1.6)	89.1	(1.9)
Total	100.0		100.0		100.0	

*Or other digestive problem.

NOTE: To determine the percentage of treated weaned heifers, the primary antibiotic used by the operation to treat a specific disease or disorder was applied to all treated heifers on the operation.

The majority of weaned heifers treated for respiratory disease were on operations that primarily treated respiratory disease with florfenicol, tetracycline, and macrolides.

Tetracycline was the primary antibiotic used on operations to treat more than 50 percent of weaned heifers with diarrhea or "other" diseases (55.1 and 67.0 percent, respectively).

f. For weaned heifers treated with antibiotics during the previous 12 months, percentage of weaned heifers by primary antibiotic used on the operation for the following diseases/disorders

	Percent Treated Weaned Heifers					
	Disease/Disorder					
	Respiratory		Diarrhea*		Other	
Primary Antibiotic Used	Pct.	Std. Error	Pct.	Std. Error	Pct.	Std. Error
Aminocyclitol	2.8	(2.5)	0.0	(--)	0.0	(--)
Aminoglycoside	0.0	(--)	0.0	(--)	0.0	(--)
Noncephalosporin beta-lactam	3.4	(0.8)	3.9	(2.8)	24.1	(14.2)
Cephalosporin	9.8	(2.8)	3.2	(2.3)	0.9	(0.9)
Florfenicol	30.3	(4.9)	10.0	(8.3)	0.0	(--)
Macrolide	15.6	(3.2)	0.2	(0.2)	0.5	(0.4)
Sulfonamide	4.1	(1.7)	2.0	(1.2)	1.7	(1.4)
Tetracycline	25.0	(4.7)	55.1	(22.2)	67.0	(16.2)
Other	9.0	(3.5)	25.6	(15.1)	5.8	(4.1)
Total	100.0		100.0		100.0	

*Or other digestive problem.

J. Mortality and Carcass Disposal

Note: Estimates in the following tables represent operations with any dairy cows.

1. Mortality

Compared with small operations, large operations had a lower percentage of preweaned heifer deaths; 7.8 percent of preweaned heifers and 1.8 percent of weaned heifers died in 2006.

Percentage of preweaned heifers and weaned heifers that died during 2006, by herd size

	Percent							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Cattle Class	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Preweaned heifers[1]	8.3	(0.4)	9.1	(0.4)	6.5	(0.4)	7.8	(0.2)
Weaned heifers[2]	1.5	(0.1)	2.0	(0.1)	1.8	(0.1)	1.8	(0.1)

[1]As a percentage of heifers born during 2006 and alive at 48 hours.
[2]As a percentage of January 1, 2007, heifer inventory (weaning age to calving).

2. Necropsy

Determining the cause of death is important in preventing future deaths and improving the health of the herd. A relatively small percentage of operations performed necropsies on preweaned heifers or weaned heifers (8.0 and 7.1, respectively) in order to determine cause of death. The percentage of operations that performed necropsies increased as herd size increased.

a. For operations that had at least one death in the following cattle classes, percentage of operations that performed necropsies to determine the cause of death, by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Cattle Class	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Preweaned heifers	4.4	(0.9)	11.9	(1.4)	22.6	(2.5)	8.0	(0.7)
Weaned heifers	5.8	(1.4)	6.9	(1.2)	13.5	(2.1)	7.1	(0.9)

Necropsies were performed for 3.5 percent of preweaned heifer deaths and 4.1 percent of weaned heifer deaths.

b. For operations that had at least one death in the following cattle classes, percentage deaths in which necropsies were performed to determine cause of death, by herd size

	Percent Deaths Necropsied							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Cattle Class	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Preweaned heifers	1.8	(0.4)	4.7	(1.1)	3.8	(0.5)	3.5	(0.4)
Weaned heifers	3.9	(1.0)	4.8	(1.5)	3.7	(0.7)	4.1	(0.6)

3. Cause of death

Scours, diarrhea, or other digestive problems accounted for the highest percentage of preweaned heifer deaths (56.5 percent), followed by respiratory problems (22.5 percent). For weaned heifers, respiratory disease was the single largest cause of death (46.5 percent). Unknown reasons, lameness or injury, and scours, diarrhea, or other digestive problems each accounted for between 12 and 15 percent of weaned heifer deaths.

Percentage of preweaned heifer deaths and weaned heifer deaths, by producer-attributed cause

	Percent Deaths			
	Preweaned Heifers		Weaned Heifers	
Producer-Attributed Cause	Percent	Std. Error	Percent	Std. Error
Scours, diarrhea, or other digestive problem	56.5	(1.3)	12.6	(1.0)
Respiratory problem	22.5	(0.9)	46.5	(1.7)
Poison	0.0	(0.0)	1.9	(0.9)
Lameness or injury	1.7	(0.3)	12.8	(1.0)
Lack of coordination, severe depression, or other CNS problem	0.3	(0.1)	0.7	(0.2)
Calving problem	5.3	(0.7)	NA	
Joint or navel problem	1.6	(0.3)	1.0	(0.3)
Other known reason	4.3	(0.7)	9.9	(1.0)
Unknown reason	7.8	(0.9)	14.6	(1.2)
Total	100.0		100.0	

4. Carcass disposal

Rendering and burial were the two most common methods of disposing of dead calves (36.5 and 32.6 percent of operations, respectively). Burial as a disposal method decreased as herd size increased. Conversely, rendering increased as herd size increased. Almost two of three large operations (65.4 percent) disposed of dead calves by rendering. Composting calf carcasses was more common on medium operations (29.5 percent) than on large operations (21.8 percent).

Percentage of operations by primary method used to dispose of dead calves, and by herd size

	Percent Operations							
	Herd Size (Number of Cows)							
	Small (Fewer than 100)		**Medium** (100-499)		**Large** (500 or More)		**All Operations**	
Disposal Method	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**	**Pct.**	**Std. Error**
Buried	36.5	(1.7)	25.5	(1.9)	7.8	(1.2)	32.6	(1.3)
Burned/ incinerated	2.5	(0.6)	0.8	(0.3)	0.3	(0.1)	2.0	(0.4)
Rendered	33.5	(1.7)	39.6	(2.2)	65.4	(2.2)	36.5	(1.3)
Composted	22.8	(1.5)	29.5	(1.9)	21.8	(1.8)	24.2	(1.2)
Landfill	1.6	(0.4)	2.2	(0.5)	1.4	(0.5)	1.7	(0.3)
Other	3.1	(0.6)	2.4	(0.7)	3.3	(1.1)	3.0	(0.5)
Total	100.0		100.0		100.0		100.0	

Section II: Methodology

A. Needs Assessment

NAHMS develops study objectives by exploring existing literature and contacting industry members and other stakeholders about their informational needs and priorities during a needs assessment phase. The objective of the needs assessment for the NAHMS Dairy 2007 study was to collect information from U.S. dairy producers and other dairy specialists about what they perceived to be the most important dairy health and productivity issues. A driving force of the needs assessment was the desire of NAHMS researchers to receive as much input as possible from a variety of producers, industry experts and representatives, veterinarians, extension specialists, universities, and dairy organizations. Information was collected via focus groups and through a Needs Assessment Survey.

Focus group teleconferences and meetings were held to help determine the focus of the study:

Teleconference, March 30, 2006
National Johne's Working Group

Meeting, Louisville, KY, April 2, 2006
National Johne's Working Group
National Institute for Animal Agriculture

Meeting, Louisville, KY, April 3, 2006
National Milk Producers Federation
Animal Health Committee

Teleconference, December 15, 2006
Bovine Alliance on Management and Nutrition

In addition, a Needs Assessment Survey was designed to ascertain the top-three management issues, diseases/disorders, and producer incentives from producers, veterinarians, extension personnel, university researchers, and allied industry groups. The survey, created in SurveyMonkey, was available online from early February through late April 2006.The survey was promoted via electronic newsletters, magazines, and Web sites. Organizations/ magazines promoting the study included Vance Publishing's "Dairy Herd Management–Dairy Alert," "Dairy Today," "Hoard's Dairyman," NMC, "Journal of the American Veterinary Medical Association," and the American Association of Bovine Practitioners. E-mail messages requesting input were also sent to cooperative members of the National Milk Producers Federation as well as State and Federal personnel. A total of 313 people completed the questionnaire.

Respondents to the Needs Assessment Survey represented the following affiliations:

- University/extension personnel—23 percent of respondents
- Producers—22 percent
- Veterinarians/consultants—20 percent
- Federal or State government personnel—15 percent
- Nutritionists—8 percent
- Allied industry personnel—8 percent
- Other—4 percent

Fort Collins, CO, May 18, 2006
CEAH Focus Group meeting

Draft objectives for the Dairy 2007 study, based on input from teleconferences, face-to-face meetings, and the online survey, were developed prior to the focus group meeting. Attendees included producers, university/extension personnel, veterinarians, and government personnel. The day-long meeting culminated in the formulation of eight objectives for the study:

1. Describe trends in dairy cattle health and management practices.
2. Evaluate management factors related to cow comfort and removal rates.
3. Describe dairy calf health and nutrition from birth to weaning and evaluate heifer disease-prevention practices.
4. Estimate the prevalence of herds infected with bovine viral diarrhea virus (BVD).
5. Describe current milking procedures and estimate the prevalence of contagious mastitis pathogens.
6. Estimate the herd-level prevalence and associated costs of *Mycobacterium avium* subspecies *paratuberculosis* (Johne's disease).
7. Describe current biosecurity practices and determine producer motivation for implementing or not implementing biosecurity practices.
8. Determine the prevalence of specific food-safety pathogens and describe antimicrobial resistance patterns.

B. Sampling and Estimation

1. State selection

The preliminary selection of States to be included in the study was done in February 2006, using the National Agricultural Statistics Service (NASS) January 27, 2006, "Cattle Report." A goal for NAHMS national studies is to include States that account for at least 70 percent of the animals and producer population in the United States. The initial review identified 16 major States representing 82.0 percent of the milk cow inventory and 79.3 percent of the operations with milk cows (dairy herds) on January 1, 2006. The States were California, Idaho, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, New Mexico, New York, Ohio, Pennsylvania, Texas, Vermont, Washington, and Wisconsin.

A memo identifying these 16 States was provided in March 2006 to the USDA:APHIS:VS:CEAH Director and, in turn, the VS Regional Directors. Each Regional Director sought input from the respective States about being included in or excluded from the study. Virginia expressed interest in participating and was included, bringing the total number of States to 17.

2. Operation selection

The list sampling frame was provided by NASS. Within each State a stratified random sample was selected. The size indicator was the number of milk cows for each operation. NASS selected a sample of dairy producers in each State for making the January 1 cattle estimates. The list sample from the January 2006 survey was used as the screening sample. Among those producers reporting 1 or more milk cows on January 1, 2006, a total of 3,554 operations were selected in the sample for contact in January 2007 during Phase I. Operations with 30 or more dairy cows that had participated in Phase I were invited to participate in data collection for Phase II. A total of 1,077 operations agreed to be contacted by veterinary medical officers to determine whether to complete Phase II.

3. Animal selection for IgG sampling

Operations that participated in Phase II of Dairy 2007 were given the opportunity to test newborn heifer calves for serum IgG and total protein levels. A maximum of 10 calves were tested from each operation. Instructions stated that to be considered for testing, calves should be 1 to 7 days of age, healthy, and should have received colostrum. For each calf tested, information was recorded about the calf's age, the quantity of colostrum the calf received at first feeding, and the method by which colostrum had been administered. A total of 2,030 serum samples were collected from 413 operations in 17 States. Serum samples were shipped on ice to the National Veterinary Services Laboratories, where IgG levels were determined by radial immunodiffusion (RID), and serum total protein was determined using a VITROS chemistry system.

Testing methods

Blood samples were received in serum separator tubes and centrifuged to separate the serum. Sample tubes were stored refrigerated at 4°C for up to 5 days and then stored at -20°C until tested. All serum samples were tested over a period of 16 days using a commercially available RID kit (Bovine IgG SRID Kit - Range 400 to 3,200 mg/dL, VMRD, Pullman, WA). The kit has an IgG detection range of 400 to 3,200 mg/dL (4 to 32 mg/mL). Briefly, 3 µl of each of 4 reference standards was placed into the first four wells of a plate from each kit. For each sample tested, 3 µl of serum was placed into a well of one plate from the kit. The plates were covered and left at room temperature for 18 to 21 hours. Subsequently, the diameters of the rings (in mm) were read using a Finescale comparator and a standard curve established. The IgG concentration of each sample was determined by finding the point on the standard curve that corresponded to the sample's ring diameter and then determining the immunoglobulin concentration that coordinated with that point. Samples with diameters that were too small to read were classified as < 4 mg/mL and those with too large of diameters were classified as > 32 mg/mL.

4. Population inferences

a. Phase I: General Dairy Management Report
Inferences cover the population of dairy producers with at least 1 milk cow in the 17 participating States. As of January 1, 2007, these States accounted for 82.5 percent (7,536,000 head) of milk cows and 79.5 percent (59,640) of operations with milk cows in the United States. (See Appendix IV for respective data on individual States.) All respondent data were statistically weighted to reflect the population from which they were selected. The inverse of the probability of selection for each operation was the initial selection weight. This selection weight was adjusted for nonresponse within each State and size group to allow for inferences back to the original population from which the sample was selected.

b. Phase II: VS Initial and Second Visits
For operations eligible for Phase II data collection (those with 30 or more dairy cows), weights were adjusted to account for operations that did not want to continue to Phase II. In addition, weights were adjusted for nonresponse to the questionnaire in each visit. The 17-State target population of operations with 30 or more dairy cows represented 82.5 percent of dairy cows and 84.7 percent of dairy operations (Appendix IV).

C. Data Collection

1. Phase I: General Dairy Management Report
From January 1 to 31, 2007, NASS enumerators administered the General Dairy Management Report questionnaire. The interview took slightly more than 1 hour.

2. Phase II: VS Initial Visit
From February 26 to April 30, 2007, Federal and State veterinary medical officers and/or animal health technicians collected data from producers during an interview that lasted approximately 2 hours.

3. Phase II: VS Second Visit
From May 1 to August 31, 2007, Federal and State veterinary medical officers and/or animal health technicians collected data from producers during an interview that lasted approximately 2 hours.

D. Data Analysis

Validation

a. Phase I: Validation—General Dairy Management Report

Initial data entry and validation for the General Dairy Management Report were performed in individual NASS State offices. Data were entered into a SAS data set. NAHMS national staff performed additional data validation on the entire data set after data from all States were combined.

b. Phase II: Validation—VS Initial and Second Visit Questionnaires

After completing the VS Initial and Second Visit questionnaires, data collectors sent them to their respective State NAHMS Coordinators, who reviewed the questionnaire responses for accuracy and sent them to NAHMS. Data entry and validation were completed by NAHMS staff using SAS.

E. Sample Evaluation

The purpose of this section is to provide various performance measurement parameters. Historically, the term "response rate" has been used as a catchall parameter, but there are many ways to define and calculate response rates. Therefore, the following tables present an evaluation based upon a number of measurement parameters, which are defined with an "x" in categories that contribute to the measurement.

1. Phase I: General Dairy Management Report

A total of 3,554 operations were selected for the survey. Of these operations, 3,304 (93.0 percent) were contacted. There were 2,519 operations that provided usable inventory information (70.9 percent of the total selected and 76.2 percent of those contacted). In addition, there were 2,194 operations (61.7 percent) that provided "complete" information for the questionnaire. Of operations that provided complete information and were eligible to participate in Phase II of the study (2,067 operations), 1,077 (52.1 percent) consented to be contacted for consideration/discussion about further participation.

Responses for Phase I: General Dairy Management Report (GDMR)					
			Measurement Parameter		
Response Category	Number Operations	Percent Operations	Contacts	Usable[1]	Complete[2]
Survey complete and VMO consent	1,077	30.3	x	x	x
Survey complete, refused VMO consent	990	27.9	x	x	x
Survey complete, ineligible[3] for VMO	127	3.6	x	x	x
No dairy cows on January 1, 2007	214	6.0	x	x	
Out of business	111	3.1	x	x	
Out of scope	6	0.2			
Refusal of GDMR	785	22.1	x		
Office hold (NASS elected not to contact)	126	3.5			
Inaccessible	118	3.3			
Total	3,554	100.0	3,304	2,519	2,194
Percent of total operations			93.0	70.9	61.7
Percent of total operations weighted[4]			94.0	74.1	59.6

[1]Usable operation—respondent provided answers to inventory questions for the operation (either zero or positive number on hand).
[2]Survey complete operation—respondent provided answers to all or nearly all questions.
[3]Ineligible—fewer than 30 head of milk cows on January 1, 2007.
[4]Weighted response—the rate was calculated using the initial selection weights.

2. Phase II: VS Initial Visit

There were 1,077 operations that agreed to be contacted by a veterinary medical officer during Phase I. Of these 1,077 operations, 582 (54.0 percent) agreed to continue in Phase II of the study and completed the VS Initial Visit questionnaire; 380 (35.3 percent) refused to participate. Approximately 10 percent of the 1,077 operations were not contacted, and 0.4 percent were ineligible because they had no dairy cows at the time they were contacted.

Responses for Phase II: VS Initial Visit

			Measurement Parameter		
Response Category	**Number Operations**	**Percent Operations**	**Contacts**	**Usable[1]**	**Complete[2]**
Survey complete	582	54.0	x	x	x
Survey refused	380	35.3	x		
Not contacted	111	10.3			
Ineligible[3]	4	0.4	x	x	
Total	1,077	100.0	966	586	582
Percent of total operations			89.7	54.4	54.0
Percent of total operations weighted[4]			87.5	50.8	50.4

[1]Usable operation—respondent provided answers to inventory questions for the operation (either zero or positive number on hand).
[2]Survey complete operation—respondent provided answers to all or nearly all questions.
[3]Ineligible—no dairy cows at time of interview, which occurred from February 26 through April 30, 2007
[4]Weighted response—the rate was calculated using the turnover weights.

3. Phase II: VS Second Visit

Of the 582 operations that completed the VS Initial Visit Questionnaire, 519 (including one operation that completed the initial visit after the deadline) completed the VS Second Visit questionnaire; 47 operations (8.1 percent) refused to participate. Approximately 3 percent of the 583 operations were not contacted, and 0.3 percent were ineligible because they had no dairy cows at the time of the VS Second Visit.

Responses for Phase II: VS Second Visit

			Measurement Parameter		
Response Category	Number Operations	Percent Operations	Contacts	Usable[1]	Complete[2]
Survey complete	519	89.0	x	x	x
Survey refused	47	8.1	x		
Not contacted	15	2.6			
Ineligible[3]	2	0.3	x	x	
Total	583	100.0	568	521	519
Percent of total operations			97.4	89.4	89.0
Percent of total operations weighted[4]			98.1	90.6	90.3

[1]Usable operation—respondent provided answers to inventory questions for the operation (either zero or positive number on hand).
[2]Survey complete operation—respondent provided answers to all or nearly all questions.
[3]Ineligible—no dairy cows at time of interview, which occurred from May 1 through August 31, 2007.
[4]Weighted response—the rate was calculated using the turnover weights.

Appendix I: Sample Profile

Responding Operations

a. Number of responding operations by herd size

Herd Size (Number of Cows)	**Phase I: General Dairy Management Report**	**Phase II: VS Initial Visit**	**Phase II: VS Second Visit**
Fewer than 100	1,028	233	211
100 to 499	691	215	188
500 or more	475	134	120
Total	2,194	582	519

b. Number of responding operations by region

Region	**Phase I: General Dairy Management Report**	**Phase II: VS Initial Visit**	**Phase II: VS Second Visit**
West	426	108	93
East	1,768	474	426
Total	2,194	582	519

Appendix II: Sample Profile for Passive Transfer Status and Growth

1. Number of calves sampled for IgG testing by age

For the IgG and total protein population estimates, calves fewer than 1 day old or older than 7 days at the time of blood collection were excluded. In addition, calves were excluded if they were ill at the time of testing, were bull calves, or had received a colostrum replacer product. A total of 214 samples were excluded for these reasons.

Number and percentage of heifer calves by age (days) when blood was collected for IgG testing

Age (Days)	Number Calves	Percent Calves
Less than 1	51	2.5
1	275	13.5
2	347	17.1
3	272	13.4
4	253	12.5
5	258	12.7
6	237	11.7
7	263	12.9
Greater than 7	60	3.0
Age not recorded	14	0.7
Total	2,030	100.0

2. Number of calves sampled for IgG testing by season

Most calves were tested in the spring or summer.

Number and percentage of heifer calves by season in which blood was collected for IgG testing

Season	Number Calves	Percent Calves
Winter (February, March)	243	12.0
Spring (April, May)	854	42.1
Summer (June, July, August)	933	45.9
Total	2,030	100.0

3. Number of preweaned heifer calves measured for growth, by age and breed

Number and percentage of preweaned heifer calves measured for growth, by age and breed

	Breed						
Age (Days)	**Holstein**	**Jersey**	**Guernsey**	**Brown Swiss**	**Other**	**Holstein/ Jersey Cross**	**Total Calves**
Less than 7	751	33	3	5	26	11	829
7 to 13	481	33	2	10	26	8	560
14 to 20	404	26	1	5	21	5	462
21 to 27	316	24	0	8	16	8	372
28 to 34	393	20	2	3	22	7	447
35 to 41	443	33	1	9	20	12	518
42 to 48	349	28	4	8	16	13	418
49 to 55	324	27	3	5	13	7	379
56 to 62	301	15	1	2	10	7	336
63 to 69	278	18	2	4	10	9	321
70 to 76	202	18	1	1	7	9	238
77 to 83	202	12	0	3	9	9	235
84 to 90	112	12	0	2	3	10	139
More than 90	111	4	0	4	5	3	127
Total	4,667	303	20	69	204	118	5,381
Percentage	86.7	5.6	0.4	1.3	3.8	2.2	100.0

Appendix III: Antibiotic/ Antimicrobial Class

Antibiotic/ Antimicrobial Class	Product Name	Active Ingredient
Aminocyclitol	Adspec®	Spectinomycin
Aminoglycoside	AmTech Neomycin Oral Solution	Neomycin
	Biosol® Liquid	Neomycin sulfate
	Gentamicin	Gentamicin
	Neomix Ag® 325 Soluble Powder	Neomycin sulfate
	Neomix® 325 Soluble Powder	Neomycin sulfate
	Neomycin 325 Soluble Powder	Neomycin sulfate
	Neomycin Oral Solution	Neomycin sulfate
	Neo-Sol 50	Neomycin sulfate
	Strep Sol 25%	Streptomycin sulfate
	Streptomycin Oral Solution	Streptomycin
Noncephalosporin beta-lactam	Agri-Cillin™	Penicillin G procaine
	Amoxi-Bol®	Amoxicillin
	Amoxi-Inject ®	Amoxicillin
	Amoxi-Mast® Intramammary Infusion	Amoxicillin
	Aquacillin™	Penicillin G procaine
	Aqua-Mast Intramammary Infusion	Penicillin G (procaine)
	Combi-Pen™-48	Penicillin G (benzathine)
	Crysticillin 300 AS Vet.	Penicillin G procaine
	Dariclox® Intramammary Infusion	Cloxacillin (sodium)
	Duo-Pen®	Penicillin G benzathine; procaine
	Durapen™	Penicillin G benzathine; procaine
	Hanford's/US Vet Masti-Clear Intramammary Infusion	Penicillin G (procaine)
	Hanford's/US Vet/Han-Pen G/Ultrapen	Penicillin G Procaine
	Hanford's/US Vet/Han-Pen-B/Ultrapen B	Penicillin G (benzathine)
	Hetacin®K Intramammary Infusion	Hetacillin (potassium)
	Microcillin	Penicillin G procaine
	Pen-G Max™	Penicillin G (procaine)
	Penicillin G Procaine	Penicillin G procaine
	PFI-Pen G®	Penicillin G procaine
	Polyflex®	Ampicillin
	Princillin Bolus	Ampicillin trihydrate
	Pro-Pen-G™ Injection	Penicillin G procaine

Antibiotic/ Antimicrobial Class	Product Name	Active Ingredient
Cephalosporin	Cefa-Lak®/Today Intramammary Infusion	Cephapirin (sodium)
	Excede™ Sterile Suspension	Ceftiofur crystalline free acid
	Excenel® RTU	Ceftiofur hydrochloride
	Naxcel®	Ceftiofur sodium
	Spectramast™ LC Intramammary Infusion	Ceftiofur
	ToDAY® Intramammary Infusion	Cephapirin (sodium)
Florfenicol	Nuflor Injectable Solution	Florfenicol
Lincosamide	Pirsue® Intramammary Infusion	Pirlimycin
Macrolide	Draxxin™	Tulathromycin
	Gallimycin®-100 Injection	Erythromycin
	Gallimycin®-36 Intramammary Infusion	Erythromycin
	Micotil® 300 Injection	Tilmicosin phosphate
	Tylan Injection 50/200 Tylosin Injection	Tylosin
Other	AS700	Chlortetracycline/sulfamethazine
	CORID 20% Soluble Powder	Amprolium
	CORID 9.6% Oral Solution	Amprolium
	Deccox-M	Decoquinate
	Linco-Spectin® Sterile Solution	Lincomycin/Spectinomycin
	TMZ	Trimethoprim sulfamethoxazole
Sulfonamide	20% SQX Solution	Sulfaquinoxaline
	Albon® Bolus	Sulfadimethoxine
	Albon® Concentrated Sol.12.5%	Sulfadimethoxine
	Albon® Injection 40%	Sulfadimethoxine
	Albon® SR Bolus	Sulfadimethoxine
	Di-Methox & 12.5% Oral Solution	Sulfadimethoxine
	Di-Methox Injection 40%	Sulfadimethoxine
	Di-Methox Soluble Powder	Sulfadimethoxine
	Liquid Sul-Q-Nox	Sulfaquinoxaline (sodium)
	SDM Injection	Sulfadimethoxine
	SDM Injection 40%	Sulfadimethoxine
	SDM Solution	Sulfadimethoxine
	Sulfadimethoxine 12.5% Oral Solution	Sulfadimethoxine
	Sulfadimethoxine Inj. 40%	Sulfadimethoxine
	Sulfadimethoxine Soluble Powder	Sulfadimethoxine
	Sulfa-Nox Concentrate	Sulfaquinoxaline
	Sulfa-Nox Liquid	Sulfaquinoxaline (sodium)
	Sulfaquinoxaline Sodium Solution 20%	Sulfaquinoxaline (sodium)
	SulfaSure™ SR Cattle/Calf Bolus	Sulfamethazine
	Sulmet® Drinking Water Solution 12.5%	Sulfamethazine (sodium)
	Sulmet® Oblets®	Sulfamethazine
	Sulmet® Soluble Powder	Sulfamethazine (sodium)
	Sustain III® Cattle Bolus	Sulfamethazine
	Vetisulid Injection	Sulfachlorpyridazine (sodium)
	Vetisulid Powder	Sulfachlorpyridazine (sodium)

Antibiotic/ Antimicrobial Class	Product Name	Active Ingredient
	Agrimycin™ 100	Oxytetracycline hydrochloride
	Agrimycin™ 200	Oxytetracycline hydrochloride
	AmTech Oxytetracycline HCL Solution Powder - 343	Oxytetracycline
	Aureomycin® Soluble Powder	Chlortetracycline hydrochloride
	Aureomycin® Soluble Powder Concentrate	Chlortetracycline hydrochloride
	Bio-Mycin® 200	Oxytetracycline
	Bio-Mycin® C	Oxytetracycline hydrochloride
	CLTC 100 MR	Chlortetracycline calcium
	Duramycin-100	Oxytetracycline hydrochloride
	Duramycin-200	Oxytetracycline hydrochloride
	Liquamycin® LA-200®	Oxytetracycline
	Maxim-200®	Oxytetracycline
	Maxim™-100	Oxytetracycline hydrochloride
	Oxy 500 and 1000 Calf Bolus	Oxytetracycline hydrochloride
	Oxybiotic™ 200	Oxytetracycline
	Oxycure™ 100	Oxytetracycline hydrochloride
	Oxy-Mycin™ 100	Oxytetracycline hydrochloride
	Oxy-Mycin™ 200	Oxytetracycline hydrochloride
Tetracycline	Oxytetracycline HCL Soluble Powder	Oxytetracycline hydrochloride
	Oxytetracycline HCL Soluble Powder 343	Oxytetracycline hydrochloride
	Panmycin® 500 Bolus	Tetracycline hydrochloride
	Pennchlor™ 64 Soluble Powder	Chlortetracycline hydrochloride
	Pennox™ 200 Injectable	Oxytetracycline
	Pennox™ 343 Soluble Powder	Oxytetracycline hydrochloride
	Polyotic® Soluble Powder	Tetracycline hydrochloride
	Promycin™ 100	Oxytetracycline hydrochloride
	Solu/Tet Soluble Powder	Tetracycline hydrochloride
	Terramycin® 343 Soluble Powder	Oxytetracycline hydrochloride
	Terramycin® Scours Tablets	Oxytetracycline hydrochloride
	Terramycin® Soluble Powder	Oxytetracycline hydrochloride
	Terra-Vet 100	Oxytetracycline hydrochloride
	Tet-324	Tetracycline hydrochloride
	Tetra-Bac 324	Tetracycline hydrochloride
	Tetracycline HCL Soluble Powder-324	Tetracycline hydrochloride
	Tetradure™ 300	Oxytetracycline
	Tetrasol Soluble Powder	Tetracycline hydrochloride
	Tet-Sol™ 324	Tetracycline hydrochloride

Appendix IV: U.S. Milk Cow Population and Operations

Number of milk cows on January 1, 2007*

		Number of Milk Cows, January 1, 2007 (Thousand Head)		Number of Operations 2006		Average Herd Size	
Region	**State**	**Milk Cows on Operations with 1 or More Head**	**Milk Cows on Operations with 30 or More Head**	**Operations with 1 or More Head**	**Operations with 30 or More Head**	**Operations with 1 or More head**	**Operations with 30 or More Head**
West	California	1,790	1,788.2	2,200	1,920	813.6	931.4
	Idaho	502	501.0	800	620	627.5	808.1
	New Mexico	360	358.9	450	180	800.0	1,993.9
	Texas	347	344.2	1,300	660	266.9	521.5
	Washington	235	234.3	790	540	297.5	433.9
	Total	3,234	3,226.6	5,540	3,920	583.8	823.1
East	Indiana	166	154.4	2,100	1,150	79.0	134.3
	Iowa	210	203.7	2,400	1,870	87.5	108.9
	Kentucky	93	86.5	2,000	1,180	46.5	73.3
	Michigan	327	320.5	2,700	1,910	121.1	167.8
	Minnesota	455	441.3	5,400	4,800	84.3	91.9
	Missouri	114	108.3	2,600	1,400	43.8	77.4
	New York	628	612.3	6,400	5,100	98.1	120.1
	Ohio	274	252.1	4,300	2,400	63.7	105.0
	Pennsylvania	550	536.3	8,700	7,000	63.2	76.6
	Vermont	140	137.2	1,300	1,100	107.7	124.7
	Virginia	100	97.0	1,300	820	76.9	118.3
	Wisconsin	1,245	1,213.9	14,900	12,800	83.6	94.8
	Total	4,302	4,163.5	54,100	41,530	79.5	100.3
Total (17 States)		7,536	7,390.1	59,640	45,450	126.4	162.6
Percent of U.S.		82.5	82.5	79.5	84.7		
Total U.S. (50 States)		9,132.0	8,958.5	74,980	53,680	121.8	166.9

*Source: NASS Cattle report, February 1, 2008, and NASS Farms, Land in Farms, and Livestock Operations 2007 Summary report, February 1, 2008. An operation is any place having one or more head of milk cows, excluding cows used to nurse calves, on hand at any time during the year.

Appendix V: Study Objectives and Related Outputs

1. Describe trends in dairy cattle health and management practices
- Part II: Changes in the U.S. Dairy Cattle Industry, 1991–2007, March 2008
- Part V: Changes in Dairy Cattle Health and Management in the United States, 1996–2007, June 2009

2. Evaluate management factors related to cow comfort and removal rates
- Part VI: Dairy Facilities and Cow Comfort on U.S. Dairy Operations, 2007, Interpretive Report, expected spring 2010

3. Describe dairy calf health and nutrition from birth to weaning and evaluate heifer disease prevention practices
- Part I: Reference of Dairy Cattle Health and Management Practices in the United States, 2007, October 2007
- Off-Site Heifer Raising on U.S. Dairy Operations, 2007, info sheet, November 2007
- Colostrum Feeding and Management on U.S. Dairy Operations, 1991–2007, info sheet, March 2008
- Part IV: Reference of Dairy Cattle Health and Management Practices in the United States, 2007, February 2009
- Calving Intervention on U.S. Dairy Operations, 2007, info sheet, February 2009
- **Heifer Calf Health and Management Practices on U.S. Dairy Operations, 2007, Interpretive Report, January 2010**
- Passive Transfer in Dairy Heifer Calves, 1991–2007, info sheet, December 2009

4. Estimate the prevalence of herds infected with bovine viral diarrhea virus (BVDV)
- Bovine Viral Diarrhea (BVD) Management Practices and Detection in Bulk Tank Milk in the United States, 2007, info sheet, October 2008

5. Describe current milking procedures and estimate the prevalence of contagious mastitis pathogens
- Part III: Reference of Dairy Cattle Health and Management Practices in the United States, 2007, September 2008
- Milking Procedures on U.S. Dairy Operations, 2007, info sheet, October 2008
- Prevalence of Contagious Mastitis Pathogens on U.S. Dairy Operations, 2007, info sheet, October 2008

6. Estimate the herd-level prevalence and associated costs of *Mycobacterium avium* subspecies *paratuberculosis*
- Johne's Disease on U.S. Dairies, 1991–2007 info sheet, April 2008

7. Describe current biosecurity practices and determine producer motivation for implementing or not implementing biosecurity practices
- Part I: Reference of Dairy Cattle Health and Management Practices in the United States, 2007, October 2007

- Part III: Reference of Dairy Cattle Health and Management Practices in the United States, 2007, September 2008
- Biosecurity Practices on U.S. Dairy operations, 1991–2007, Interpretive Report, expected winter 2009–10

8. Determine the prevalence of specific food-safety pathogens and describe antimicrobial resistance patterns

- Antibiotic Use on U.S. Dairy Operations, 2002 and 2007, info sheet, September 2008
- Prevalence of *Listeria* and *Salmonella* in Bulk Tank Milk and In-line Filters on U.S. Dairies, 2007, info sheet, July 2009
- *Salmonella* and *Campylobacter* on U.S. Dairy Operations, 2002–07, info sheet, July 2009
- Food Safety Pathogens Isolated from U.S. Dairy Operations, 2007, Interpretive Report, expected spring 2010
- Prevalence of *Coxiella burnetti* on U.S. Dairy Operations, 2007, info sheet, expected spring 2010

Additional information sheets

- Dairy Cattle Identification Practices in the United States, 2007, info sheet, November 2007
- Bovine Leukosis Virus (BLV) on U.S. Dairy Operations, 2007, info sheet, September 2008
- Reproduction Practices on U.S. Dairy Operations, 2007, info sheet, February 2009
- Injection Practices on U.S. Dairy Operations, 2007, info sheet, February 2009
- Methicillin-Resistant *Staphylococcus aureus* (MRSA) Isolation from Bulk Tank Milk in the United States, 2007, info sheet, expected spring 2010

Appendix VI: References

1 The Merck Veterinary Manual, 8th Edition. Whitehouse, NJ: Merck and Company, Inc., 1998.

2 Abe F, Ishibashi N, Shimamura S. Effect of administration of bifidobacteria and lactic acid bacteria to newborn calves and piglets. J Dairy Sci 1995 78:2838-2846.

3 Adams GD, Bush LJ, Horner JL, Staley TE. Two methods for administering colostrum to newborn calves. J Dairy Sci 1985 68:773-775.

4 Allaway, WH. Selenium concentrations in crops from different parts of the United States. Georgia Nutr Conf Feed Manuf 1969 Atlanta University, Atlanta, GA.

5 Anderson KL, Nagaraja TG, Morrill JL, Reddy PG, Avery TB, Anderson NV. Performance and ruminal changes of early-weaned calves fed lasalocid. J Anim Sci 1988 66:806-813.

6 Arthur GH, Noakes DE, Pearson H. Veterinary Reproduction and Obstetrics. London, UK: Bailliere Tindall, 1989.

7 Berge AC, Lindeque P, Moore DA, Sischo WM. A clinical trial evaluating prophylactic and therapeutic antibiotic use on health and performance of preweaned calves. J Dairy Sci 2005 88:2166-2177.

8 Besser TE, Gay CC, Pritchett L. Comparison of three methods of feeding colostrum to dairy calves. J Am Vet Med Assoc 1991 198:419-422.

9 Block E, Gadbois P. Efficacy of morantel tartrate on milk production of dairy cows: a field study. J Dairy Sci 1986 69:1135-1140.

10 Block E, McDonald WA, Jackson BA. Efficacy of Levamisol on milk production of dairy cows: a field study. J Dairy Sci 1987 70:1080-1085.

11 Bovine Alliance on Management and Nutrition. A Guide to Colostrum and Colostrum Management for Dairy Calves, 2001 revision. Accessed December 2009 http://www.aphis.usda.gov/vs/ceah/ncahs/nahms/dairy/bamn/BAMNColostrum.pdf

12 Bovine Alliance on Management and Nutrition. A Guide to Dairy Calf Feeding and Management, 2003 revision. Accessed December 2009 http://www.aphis.usda.gov/vs/ceah/ncahs/nahms/dairy/bamn/BAMNGuide_to_Dairy_Feeding.pdf

13 Bradley RE, Bliss DH, Newby TJ. Efficacy of a morantel sustained-release bolus for the control of gastrointestinal nematodes in Florida dairy heifers. Am J Vet Res 1986 47:2385-2388.

14 Brakel WJ, Rife DC, Salisbury SM. Factors associated with the duration of gestation in dairy cattle. J Dairy Sci 1952 35:179-194.

15 Brignole TJ, Stott GH. Effect of suckling followed by bottle feeding colostrum on immunoglobulin absorption and calf survival. J Dairy Sci 1980 63:451-456.

16 Brody S. Bioenergetics and Growth. New York: Hafner Publishing Co., Inc., 1945.

17 Brunsvold RE , Cramer CO, Larsen HJ. Behavior of dairy calves reared in hutches as affected by temperature. Transactions of the American Society of Agricultural and Biological Engineers 1985 28:1265-1268.

18 Burton JL, Kennedy BW, Burnside EB, Wilkie BN, Burton JH. Variation in serum concentrations of immunoglobulins G, A, and M in Canadian Holstein-Friesian calves. J Dairy Sci 1989 72:135-149.

19 Butler JE. Bovine immunoglobulins: an augmented review. Vet Immunol Immunopathol 1983 4:43-152.

20 Callaway TR, Edrington TS, Rychlik JL et al. Ionophores: their use as ruminant growth promotants and impact on food safety. Curr Issues Intest Microbiol 2003 4:43-51.

21 Chigerwe M, Dawes ME, Tyler JW, Middleton JR, Moore MP, Nagy DM. Evaluation of a cow-side immunoassay kit for assessing IgG concentration in colostrum. J Am Vet Med Assoc 2005 227:129-131.

22 Corbett, RB. Utilizing milk replacer to maximize early growth rates Part 1:Traditional milk replacers. Am Assoc Bov Pract Mtg 2007, Vancouver, BC.

23 Cortese VS, Grooms DL, Ellis J, Bolin SR, Ridpath JF, Brock KV. Protection of pregnant cattle and their fetuses against infection with bovine viral diarrhea virus type 1 by use of a modified-live virus vaccine. Am J Vet Res 1998 59:1409-1413.

24 Dargatz DA, Garry FB, Traub-Dargatz JL. An introduction to biosecurity of cattle operations. Vet Clin North Am Food Anim Pract 2002 18:1-5.

25 Davis CD, Drackley JK. The Development, Nutrition and Management of the Young Calf. Ames, Iowa: Iowa State University Press, 1998.

26 Doherty TJ, Kattesh HG, Adcock RJ et al. Effects of a concentrated lidocaine solution on the acute phase stress response to dehorning in dairy calves. J Dairy Sci 2007 90:4232-4239.

27 Donovan DC, Franklin ST, Chase CC, Hippen AR. Growth and health of Holstein calves fed milk replacers supplemented with antibiotics or Enteroguard. J Dairy Sci 2002 85:947-950.

28 Eicher-Pruiett SD, Morrill JL, Nagaraja TG, Higgins JJ, Anderson NV, Reddy PG. Response of young dairy calves with lasalocid delivery varied in feed sources. J Dairy Sci 1992 75:857-862.

29 Faber SN, Faber NE, McCauley TC, Ax RL. Effects of colostrum ingestion on lactational performance. Prof Anim Sci 2005 21:425.

30 Fahey JL, McKelvey EM. Quantitative determination of serum immunoglobulins in antibody-agar plates. J Immunol 1965 94:84-90.

31 FAO/WHO. Health and Nutritional Properties of Probiotics in Food including Powder Milk with Live Lactic Acid Bacteria. Report of a Joint FAO/WHO Expert Consultation on Evaluation of Health and Nutritional Properties of Probiotics in Food Including Powder Milk with Live Lactic Acid Bacteria, 2001.

32 Faulkner PM, Weary DM. Reducing pain after dehorning in dairy calves. J Dairy Sci 2000 83:2037-2041.

33 Ficken MD, Ellsworth MA, Tucker CM, Cortese VS. Effects of modified-live bovine viral diarrhea virus vaccines containing either type 1 or types 1 and 2 BVDV on heifers and their offspring after challenge with noncytopathic type 2 BVDV during gestation. J Am Vet Med Assoc 2006 228:1559-1564.

34 Foley JA, Otterby DE. Availability, storage, treatment, composition, and feeding value of surplus colostrum: A Review. J Dairy Sci 1978 61:1033-1060.

35 Fulton RW, Johnson BJ, Briggs RE et al. Challenge with bovine viral diarrhea virus by exposure to persistently infected calves: protection by vaccination and negative results of antigen testing in nonvaccinated acutely infected calves. Can J Vet Res 2006 70:121-127.

36 Godden S. Colostrum management for dairy calves. Vet Clin North Am Food Anim Pract 2008 24:19-39.

37 Godden SM, Fetrow JP, Feirtag JM, Green LR, Wells SJ. Economic analysis of feeding pasteurized nonsaleable milk versus conventional milk replacer to dairy calves. J Am Vet Med Assoc 2005 226:1547-1554.

38 Godden SM, Smith S, Feirtag JM, Green LR, Wells SJ, Fetrow JP. Effect of on-farm commercial batch pasteurization of colostrum on colostrum and serum immunoglobulin concentrations in dairy calves. J Dairy Sci 2003 86:1503-1512.

39 Godden S, Fetrow J, Feirtag J, Wells S, Green L. A review of issues surrounding the feeding of pasteurized non saleable milk and colostrum. Am Assoc Bov Pract Mtg, 2007, Vancouver, BC.

40 Graf B, Senn M. Behavioral and physiological responses of calves to dehorning by heat cauterization with or without local anaesthesia. Appl Anim Behav Sci 1999 62:153-171.

41 Grondahl-Nielsen C, Simonsen HB, Lund JD, Hesselholt M. Behavioural, endocrine and cardiac responses in young calves undergoing dehorning without and with use of sedation and analgesia. Vet J 1999 158:14-20.

42 Harrison JH, Hancock DD, Conrad HR. Vitamin E and selenium for reproduction of the dairy cow. J Dairy Sci 1984 67:123-132.

43 Heinrichs AJ. Raising dairy replacements to meet the needs of the 21st century. J Dairy Sci 1993 76:3179-3187.

44 Heinrichs AJ, Bush GJ. Evaluation of decoquinate or lasalocid against coccidiosis from natural exposure in neonatal dairy calves. J Dairy Sci 1991 74:3223-3227.

45 Heinrichs J, Lammers B. Monitoring Dairy Heifer Growth. The Pennsylvania State University, 1998.

46 Heuer C, Healy A, Zerbini C. Economic effects of exposure to bovine viral diarrhea virus on dairy herds in New Zealand. J Dairy Sci 2007 90:5428-5438.

47 Hopkins BA. Effects of the method of calf starter delivery and effects of weaning age on starter intake and growth of Holstein calves fed milk once daily. J Dairy Sci 1997 80:2200-2203.

48 Hopkins BA, Hunt E, Hunt LD. Effect of milk feeding regimen and weaning age on growth and performance of Holstein calves. J Dairy Sci 1993 76(suppl. 1):274.

49 Houe H. Epidemiological features and economical importance of bovine virus diarrhoea virus (BVDV) infections. Vet Microbiol 1999 64:89-107.

50 James RE, Polan CE. Effect of orally administered duodenal fluid on serum proteins in neonatal calves. J Dairy Sci 1978 61:1444-1449.

52 Johnson JL, Godden SM, Molitor T, Ames T, Hagman D. Effects of feeding heat-treated colostrum on passive transfer of immune and nutritional parameters in neonatal dairy calves. J Dairy Sci 2007 90:5189-5198.

53 Jones C, Heinrichs J. Spreadsheet to Compare Cost of Milk and Milk Replacer. 2007. http://www.das.psu.edu/research-extension/dairy/nutrition/xls/calfmilkcostcompare.xls. Accessed 12-4-2009.

54 Kehoe SI, Jayarao BM, Heinrichs AJ. A survey of bovine colostrum composition and colostrum management practices on Pennsylvania dairy farms. J Dairy Sci 2007 90:4108-4116.

55 Kelling CL. Evolution of bovine viral diarrhea virus vaccines. Vet Clin North Am Food Anim Pract 2004 20:115-129.

56 Kertz AF, Reutzel LF, Mahoney JH. Ad libitum water intake by neonatal calves and its relationship to calf starter intake, weight gain, feces score, and season. J Dairy Sci 1984 67:2964-2969.

57 Khuntia A, Chaudhary LC. Performance of male crossbred calves as influenced by substitution of grain by wheat bran and the addition of lactic acid bacteria to diet. Asian-Australasian J An Sci 2002 15:188-194.

58 Kincaid RL. The biological basis for selenium requirements of animals. Prof Anim Sci 1995 11:26-29.

59 Klobasa F, Goel MC, Werhahn E. Comparison of freezing and lyophilizing for preservation of colostrum as a source of immunoglobulins for calves. J Anim Sci 1998 76:923-926.

60 Kovacs F, Magyar T, Rinehart C, Elbers K, Schlesinger K, Ohnesorge WC. The live attenuated bovine viral diarrhea virus components of a multi-valent vaccine confer protection against fetal infection. Vet Microbiol 2003 96:117-131.

61 Laden SA, Wohlt JE, Zajac PK, Carsia RV. Effects of stress from electrical dehorning on feed intake, growth, and blood constituents of Holstein heifer calves. J Dairy Sci 1985 68:3062-3066.

62 Langford FM, Weary DM, Fisher L. Antibiotic resistance in gut bacteria from dairy calves: a dose response to the level of antibiotics fed in milk. J Dairy Sci 2003 86:3963-3966.

63 Larson RL, Brodersen BW, Grotelueschen DM et al. Considerations for bovine viral diarrhea (BVD) testing. Bovine Pract 2005 39:96-100.

64 Levieux D, Ollier A. Bovine immunoglobulin G, beta-lactoglobulin, alpha-lactalbumin and serum albumin in colostrum and milk during the early post partum period. J Dairy Res 1999 66:421-430.

65 Ley S, Waterman A, Livingston A. Variation in the analgesic effects of xylazine in different breeds of sheep. Vet Rec 1990 126:508.

66 Lombard JE, Garry FB, Tomlinson SM, Garber LP. Impacts of dystocia on health and survival of dairy calves. J Dairy Sci 2007 90:1751-1760.

67 Loxton ID, Toleman MA, Holmes AE. The effect of dehorning Brahman crossbred animals of four age groups on subsequent bodyweight gain. Aust Vet J 1982 58:191-193.

68 McCluskey BJ. Biosecurity for arthropod-borne diseases. Vet Clin North Am Food Anim Pract 2002 18:99-114, vi-vii.

69 McGilliard AD, Jacobson NL, Sutton JD. Physiological development of the ruminant stomach. In: Physiology of Digestion in the Ruminant. Washington D.C., Butterworth, 1965.

70 McGuirk SM, Collins M. Managing the production, storage, and delivery of colostrum. Vet Clin North Am Food Anim Pract 2004 20:593-603.

71 McMeekan CM, Mellor DJ, Stafford KJ, Bruce RA, Ward RN, Gregory NG. Effects of shallow scoop and deep scoop dehorning on plasma cortisol concentrations in calves. N Z Vet J 1997 45:72-74.

72 McMeekan CM, Stafford KJ, Mellor DJ, Bruce RA, Ward RN, Gregory NG. Effects of regional analgesia and/or a non-steroidal anti-inflammatory analgesic on the acute cortisol response to dehorning in calves. Res Vet Sci 1998 64:147-150.

73 Mee JF. Newborn dairy calf management. Vet Clin North Am Food Anim Pract 2008 24:1-17.

74 Meyer CL, Berger PJ, Koehler KJ. Interactions among factors affecting stillbirths in Holstein cattle in the United States. J Dairy Sci 2000 83:2657-2663.

75 Meyer CL, Berger PJ, Koehler KJ, Thompson JR, Sattler CG. Phenotypic trends in incidence of stillbirth for Holsteins in the United States. J Dairy Sci 2001 84:515-523.

76 Meylan M, Rings DM, Shulaw WP, Kowalski JJ, Bech-Nielsen S, Hoffsis GF. Survival of Mycobacterium paratuberculosis and preservation of immunoglobulin G in bovine colostrum under experimental conditions simulating pasteurization. Am J Vet Res 1996 57:1580-1585.

77 Molla A. Immunoglobulin levels in calves fed colostrum by stomach tube. Vet Rec 1978 103:377-380.

78 Moore M, Tyler JW, Chigerwe M, Dawes ME, Middleton JR. Effect of delayed colostrum collection on colostral IgG concentration in dairy cows. J Am Vet Med Assoc 2005 226:1375-1377.

79 Moore SJ, VandeHaar MJ, Sharma BK et al. Effects of altering dietary cation-anion difference on calcium and energy metabolism in peripartum cows. J Dairy Sci 2000 83:2095-2104.

80 Morin DE, Constable PD, Maunsell FP, McCoy GC. Factors associated with colostral specific gravity in dairy cows. J Dairy Sci 2001 84:937-943.

81 Morisse JP, Cotte JP, Huonnic D. Effect of dehorning on behavior and plasma cortisol responses in young calves. Appl Anim Behav Sci 1995 43:239-247.

82 Mortimer RG. Calving Management Manual, Chapter 6: Calving and Handling Calving Difficulties. 2009. Available at: www.cvmbs.colostate.edu/ilm/projects/neonatal/Calving%20and%20Handling%20Calving%20Difficulties.pdf (accessed 3/13/09)

84 Orskov ER. Reflex closure of the esophageal groove and its potential application in ruminant nutrition. S Afr J Anim Sci 1972 2:169-176.

85 Orskov ER, Benzie D, Kay RN. The effects of feeding procedure on closure of the oesophageal groove in young sheep. Br J Nutr 1970 24:785-795.

86 Otterby DE, Linn JG. Advances in nutrition and management of calves and heifers. J Dairy Sci 1981 64:1365-1377.

87 Petrie NJ, Mellor DJ, Stafford KJ, Bruce RA, Ward RN. Cortisol responses of calves to two methods of disbudding used with or without local anaesthetic. N Z Vet J 1996 44:9-14.

88 Philipsson J, Foulley JL, Lederer J, Liboriussen T, Osinga A. Sire evaluation standards and breeding strategies for limiting dystocia and stillbirth. Report of an EEC/EAAP working group. Livestock Production Science 1979 6(2):111-127.

89 Pritchett LC, Gay CC, Hancock DD, Besser TE. Evaluation of the hydrometer for testing immunoglobulin G1 concentrations in Holstein colostrum. J Dairy Sci 1994 77:1761-1767.

90 Quigley JD III, Drewry JJ, Murray LM, Ivey SJ. Effects of lasalocid in milk replacer or calf starter on health and performance of calves challenged with Eimeria species. J Dairy Sci 1997 80:2972-2976.

91 Rajala P, Castren H. Serum immunoglobulin concentrations and health of dairy calves in two management systems from birth to 12 weeks of age. J Dairy Sci 1995 78:2737-2744.

92 Scibilia LS, Muller LD, Kensinger RS, Sweeney TF, Shellenberger PR. Effect of environmental temperature and dietary fat on growth and physiological responses of newborn calves. J Dairy Sci 1987 70:1426-1433.

93 Selim SA, Cullor JS. Number of viable bacteria and presumptive antibiotic residues in milk fed to calves on commercial dairies. J Am Vet Med Assoc 1997 211:1029-1035.

94 Smith KL, Harrison JH, Hancock DD, Todhunter DA, Conrad HR. Effect of vitamin E and selenium supplementation on incidence of clinical mastitis and duration of clinical symptoms. J Dairy Sci 1984 67:1293-1300.

95 Stabel JR, Hurd S, Calvente L, Rosenbusch RF. Destruction of Mycobacterium paratuberculosis, Salmonella spp., and Mycoplasma spp. in raw milk by a commercial on-farm high-temperature, short-time pasteurizer. J Dairy Sci 2004 87:2177-2183.

96 Stewart S, Godden S, Bey R et al. Preventing bacterial contamination and proliferation during the harvest, storage, and feeding of fresh bovine colostrum. J Dairy Sci 2005 88:2571-2578.

97 Stobo IJ, Roy JH, Gaston HJ. Rumen development in the calf. 1. The effect of diets containing different proportions of concentrates to hay on rumen development. Br J Nutr 1966 20:171-188.

98 Stott GH, Marx DB, Menefee BE, Nightengale GT. Colostral immunoglobulin transfer in calves I. Period of absorption. J Dairy Sci 1979 62:1632-1638.

99 Streeter RN, Hoffsis GF, Bech-Nielsen S, Shulaw WP, Rings DM. Isolation of *Mycobacterium paratuberculosis* from colostrum and milk of subclinically infected cows. Am J Vet Res 1995 Oct;56(10):1322-4.

100 Sutherland MA, Mellor DJ, Stafford KJ, Gregory NG, Bruce RA, Ward RN. Cortisol responses to dehorning of calves given a 5-h local anaesthetic regimen plus phenylbutazone, ketoprofen, or adrenocorticotropic hormone prior to dehorning. Res Vet Sci 2002 73:115-123.

101 Swan H, Godden S, Bey R, Wells S, Fetrow J, Chester-Jones H. Passive transfer of immunoglobulin G and preweaning health in Holstein calves fed a commercial colostrum replacer. J Dairy Sci 2007 90:3857-3866.

102 Sylvester SP, Stafford KJ, Mellor DJ, Bruce RA, Ward RN. Behavioural responses of calves to amputation dehorning with and without local anaesthesia. Aust Vet J 2004 82:697-700.

103 Timmerman HM, Mulder L, Everts H et al. Health and growth of veal calves fed milk replacers with or without probiotics. J Dairy Sci 2005 88:2154-2165.

104 Toullec R, Guilloteau P. Research into the digestive physiology of the milk-fed calf. In: Nutrition and digestive physiology of monogastric farm animals. Pudoc, Wageningen, 1989.

105 Tyler JW, Hancock DD, Parish SM et al. Evaluation of 3 assays for failure of passive transfer in calves. J Vet Intern Med 1996 10:304-307.

106 Tyler JW, Parish SM, Besser TE, Van Metre DC, Barrington GM, Middleton JR. Detection of low serum immunoglobulin concentrations in clinically ill calves. J Vet Intern Med 1999 13:40-43.

107 USDA. 2007. Dairy 2007, Part I:Reference of Dairy Cattle Health and Management Practices in the United States, 2007 USDA-APHIS-VS, CEAH. Fort Collins, CO #N480.1007

108 Velazquez OC, Lederer HM, Rombeau JL. Butyrate and the colonocyte. Implications for neoplasia. Dig Dis Sci 1996 41:727-739.

109 Vickers KJ, Niel L, Kiehlbauch LM, Weary DM. Calf response to caustic paste and hot-iron dehorning using sedation with and without local anesthetic. J Dairy Sci 2005 88:1454-1459.

110 Wallace RL. Biosecurity and animal health protocols during herd expansion, 2001. http://www.livestocktrail.uiuc.edu/biosecurity/papers/herd_expansion.htm. Accessed 12-4-2009.

111 Warner RG, Flatt WP. Anatomical development of the ruminant stomach. In: Physiology of Digestion in the Ruminant. Washington DC: Butterworths, 1965.

112 Weaver DM, Tyler JW, VanMetre DC, Hostetler DE, Barrington GM. Passive transfer of colostral immunoglobulins in calves. J Vet Intern Med 2000 14:569-577.

113 Wells SJ. Biosecurity on dairy operations: hazards and risks. J Dairy Sci 2000 83:2380-2386.

114 Wells SJ, Dargatz DA, Ott SL. Factors associated with mortality to 21 days of life in dairy heifers in the United States. Prev Vet Med 1996 29(1):9-19.

115 Wolf CA. Custom dairy heifer grower industry characteristics and contract terms. J Dairy Sci 2003 86:3016-3022.

116 Wray C, Furniss S, Benham CL. Feeding antibiotic-contaminated waste milk to calves—effects on physical performance and antibiotic sensitivity of gut flora. Br Vet J 1990 146:80-87.

117 Yazwinski TA, Gibbs HC. Survey of helminth infections in Maine dairy cattle. Am J Vet Res 1975 36:1677-1682.